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CONTENTS

CORRECTION

REVIEW, April, 1924:

Page 209, legends to Figures 2, 3, 4, 5, 6, and 7 *have been interchanged;* the correct month in each case is given in the body of the figure; otherwise the legends are correct.

710—24†——1

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THE OCCURRENCE OF HAIL

EDITOR'S NOTE.—In response to the demand for more specific data on the occurrence of hail in the United States, the Weather Bureau began in the April number of this REVIEW the publication of reports on the occurrence of hailstorms as observed by its regular and cooperative observers, numbering approximately 5,200. Cooperative observers report directly to the Weather Bureau officials in charge of the several section centers and these officials in turn transmit the reports to the Central Office in Washington, D. C. The reports are incorporated in the table which hitherto has borne the title "Severe Local Storms." That table will be found on pages 282–284 of this REVIEW, and it will appear in approximately the same position hereafter.

ASCENSIONAL RATE OF PILOT BALLOONS[1]

By WILLIAM C. HAINES, Meteorologist

(Weather Bureau, Washington, May 6, 1924)

Pilot balloons furnish us with an efficient and economical as well as a fairly accurate means of determining the direction and velocity of the wind in the free air. The two-theodolite method, when used in connection with a base line of 2,500 meters or more in length and well chosen with respect to the direction of the wind, will give results as accurate as the readings of the theodolites. However, in exceptionally long observations, an hour or more in length, or when the balloon is moving in the vicinity of the direction of the base line, the results are not so satisfactory. In either case the angles of the triangle become so small that a slight error in the reading of the angles makes a considerable error in the computed distance and altitude of the balloon, and therefore an error in the resulting wind velocity and direction.

In general, the single-theodolite method is better adapted for the procurement of free-air data than is the double-theodolite method, but the accuracy of its results is dependent upon the accuracy with which the altitude of the balloon is known. The Meteorological Section, Signal Corps, carried on during the war an extended investigation in order to develop a formula that would give the ascensional rate of balloons.[2] As a result of these studies, the following empirical formula which is a modification of the Dines' formula was developed and adopted as the one giving the best results:

$$V=71\left(\frac{l^3}{L^2}\right)^{.208} \qquad (1)$$

in which V is the rate of ascent in m./min., l is the free lift or ascensional force in grams, and L is the free lift plus the weight of the balloon. This formula was based on about 1,000 two-theodolite observations taken in all seasons of the year and at all times of the day. After the war a slight revision was made as the result of further study and the inclusion of additional data secured by the Weather Bureau and the Signal Corps. The revision consisted of a change in the constant from 71 to 72 and of the introduction of small additive corrections for the first five minutes of ascent.[3] The Weather Bureau has used this revised formula since April, 1921.

The two-theodolite work has been continued by the Weather Bureau at the various aerological stations in order to verify the ascensional rate formula in use; also to determine to what extent the ascensional rate is affected by convection, and to study the behavior of balloons at high altitudes. The first step taken toward this end was to standardize the ascensional rate of balloons. Since the latter part of 1921, the balloons have been inflated by an automatic weighing device to give an ascensional rate of 180 m./min in both single and double theodolite observations. The balloons used are 6 inch rubber weighing from 25 to 35 grams, and when inflated are approximately 60 centimeters in diameter. The a. m. observations are ordinarily taken between 7 and 8 and the p. m. between 3 and 4, 75th meridian time.

This paper is based on the study of all two-theodolite observations taken by the Weather Bureau since the standardized ascensional rate was adopted, or on more than 800 observations of 10 minutes or more in length. The following method was employed to determine the actual rate of ascent of the balloons at successive altitudes: In order to show to what height convection influences the ascensional rate, the average rate of ascent for each minute for the first 10 minutes was obtained. From altitudes of 2,000 to 11,000 meters, the average rates were obtained for four-minute periods immediately above each thousand-meter level, and above 11,000 meters the average rates for five-minute periods were taken. The data were treated in this manner to get the ascensional rate through the various strata of air from the surface to the highest altitude, independent of convection which might have affected the ascensional rate in the lower levels. The a. m. data, p. m. data, and a. m. and p. m. data combined, were considered separately. The means were plotted as ordinates and the altitudes as abscissae, and empirical curves were fitted to the points by the method of least squares. It was found that the points were best fitted by two equations of the form of

$$R=ah^2+bh+c \qquad (2)$$

in which R is the rate of ascent per minute, h is the altitude in meters and a, b and c are constants. The original data to which the curves were fitted are given in Table 1.

[1] Presented before American Meteorological Society at Washington, April 30, 1924.
[2] Sherry, B. J. and Waterman, A. T., The military Mereorological Service in the United States during the War. MO. WEATHER REV. April, 1919. 47: 218.
[3] Sherry, B. J. The Rate of Ascent of Pilot Balloons. MO. WEATHER REV. Dec. 1920, 48: 692-694.

TABLE 1.—*Number of observations and average rate of ascent at various altitudes. Ascensional rate-altitude curves based on these data*

[Sections of this table show, respectively, one-minute, four-minute, and five-minute averages, as explained in the text]

a. m.			p. m.			a. m. and p. m. combined		
No.	Altitude	Rate	No.	Altitude	Rate	No.	Altitude	Rate
292	102	203.7	513	111	222.3	805	108	215.6
292	296	184.6	513	325	205.8	805	324	197.1
292	478	180.9	513	530	203.6	805	511	196.4
292	660	181.1	513	725	196.8	805	704	190.4
292	841	181.5	513	923	190.6	805	894	187.3
292	1,023	181.2	513	1,110	184.7	805	1,079	183.5
292	1,203	179.5	513	1,295	183.9	805	1,261	182.2
292	1,384	183.0	513	1,478	181.8	805	1,443	182.3
292	1,566	180.1	513	1,660	183.2	805	1,626	182.1
292	1,747	181.4	513	1,843	182.9	805	1,808	181.3
238	2,451	181.1	434	2,455	183.5	672	2,453	182.6
176	3,458	184.0	331	3,470	184.0	507	3,460	184.0
127	4,458	184.0	248	4,450	182.8	375	4,456	184.8
91	5,461	183.8	187	5,458	185.8	278	5,458	184.8
72	6,455	181.4	135	6,473	187.6	207	6,467	185.4
57	7,456	184.2	106	7,475	189.3	163	7,469	187.5
44	8,469	190.4	85	8,470	190.6	129	8,470	190.5
29	9,475	189.8	59	9,478	192.9	88	9,490	191.8
18	10,508	188.2	35	10,493	192.8	53	10,498	191.2
4	11,437	180.0	18	11,656	200.9	22	11,586	195.1
2	12,445	223.7	9	12,640	204.7	11	12,597	208.9
1	13,503	199.0	5	13,591	176.0	6	13,572	181.2
			2	14,695	221.3	2	14,693	222.5

The first four minutes of the a. m. data were fitted by the equation,

$$R = .00013755h^2 - .14505h + 217.353 \tag{3}$$

and the remainder of the data by the equation,

$$R = .0000002227h^2 - .001358h + 182.884; \tag{4}$$

the first eight minutes of the p. m. data by the equation,

$$R = .00001714h^2 - .05578h + 226.453 \tag{5}$$

and the remainder of the data by the equation,

$$R = .0000001214h^2 - .0002299h + 182.973; \tag{6}$$

and the first ten minutes of the a. m. and p. m. data combined were fitted by the equation,

$$R = .00001682h^2 - .04914h + 216.828 \tag{7}$$

and the remainder of the data by the equation,

$$R = .0000001737h^2 - .0008857h + 183.827. \tag{8}$$

Figure 1 represents these equations fitted to the data. Inspection shows the resulting ascensional rate-altitude curves to be decidedly similar, excepting in the lower levels where convection is an important factor. All three curves lie slightly above the 180 m./min. line between the point where convection ceases and the 5 or 6 thousand meter level, thereafter diverging at first slowly, and later more rapidly until the 200 m./min. line is reached by all three curves at an altitude of 14,000 meters, the limit of the a. m. curve. It is evident that in the morning hours before convection sets in no additive corrections are necessary, except to the first and second minutes, whereas in the afternoon somewhat larger corrections are needed than those that have been adopted. Also the assumed altitudes in the higher levels should be modified somewhat. Owing to insufficient data, and the liability of error in computation, the results above 12,000 or 13,000 meters should be held in abeyance until more data are collected at high altitudes.

In order to compare the results of the ascensional rate-altitude curves with our assumed altitudes for the various minutes, it becomes necessary to obtain the altitude as a function of the time. From the Calculus, we have,

$$R = \frac{dh}{dt} = ah^2 + bh + c \tag{9}$$

Integrating this expression and evaluating the constant of integration, we obtain the equation,

$$t = \frac{2}{\sqrt{4ac - b^2}} \tan^{-1} \frac{2ah\ b}{\sqrt{4ac - b^2}} - \frac{2}{\sqrt{4ac - b^2}} \tan^{-1} \frac{b}{\sqrt{4ac - b^2}} \tag{10}$$

which is the general equation of the time-altitude curves. Plotting this equation by substituting the values of a, b, and c in equations (3)–(8) of our ascensional rate-altitude curves we obtain for various values of h the three time-altitude curves as shown in Figure 2. It will be noted that these three curves lie close together with the same

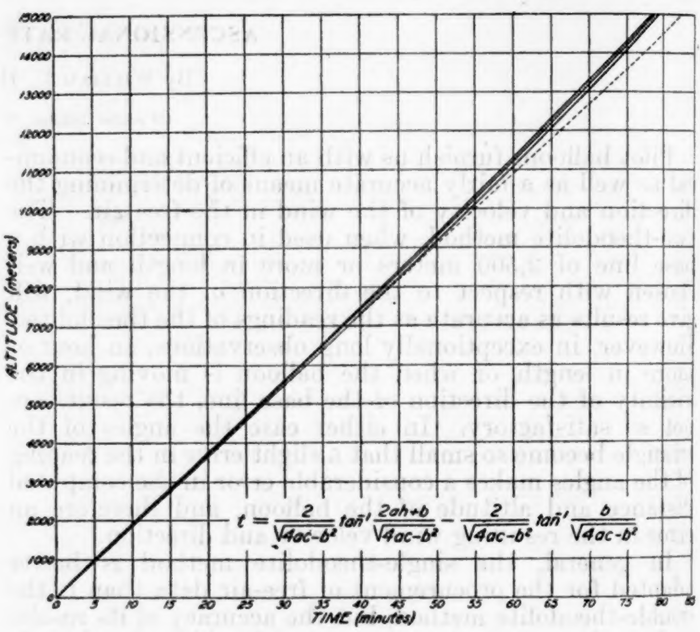

FIG. 1.—Ascensional rate-altitude curves for the a. m. data, p. m. data, and a. m. and p. m. data combined.

general variation from the assumed curve. In the lower levels the a. m. curve lies below the assumed and the p. m. curve above, whereas the curve of the combined a. m. land p. m. data practically coincides with the assumed curve.[4] In the higher levels all three curves lie above the assumed. Table 2 gives the altitudes shown by the curves, and the altitudes assumed for the first five minutes and at ten minute intervals thereafter.

TABLE 2.—*Altitudes shown by time-altitude curves and assumed heights for the first five minutes and at ten-minute intervals thereafter*

Minute	a. m.	p. m.	a. m. and p. m. combined	Assumed
1	202	223	210	216
2	398	429	413	414
3	571	631	609	612
4	752	826	800	801
5	930	1,012	989	990
10	1,830	1,930	1,900	1,890
20	3,640	3,740	3,720	3,600
30	5,450	5,580	5,550	5,490
40	7,290	7,460	7,410	7,290
50	9,160	9,330	9,280	9,090
60	11,070	11,290	11,220	10,890
70	13,060	13,270	13,200	12,690
80	15,140	15,320	15,260	14,490

[4] Cf. Figure 4 in Pilot-balloon observations at San Juan, Porto Rico, Mo. WEATHER REV. January, 1924, 52: 22–26. (Discussion by W. R. Gregg and W. C. Haines.)

The curves in Figure 2 show averages. It is desirable also to know how much, or how little, the individual observations depart from these averages. In order to determine the departures in a more or less general manner, the average altitude at the end of the tenth minute was considered, and departures from this determined. This particular altitude was selected as representative, because it is great enough to show the maximum effects of convection, and still include the majority of observations. The number of individual observations that departed 5, 10, 15 per cent etc., above and below this average was determined. This was done for the a. m., p. m., and combined a. m. and p. m. observations. These departures are shown by means of frequency histograms in Figure 3. It will be noted that in the morning hours when convection is of little consequence, 77 per cent of the observations lie within 5 per cent of the average, and 94 per cent within 10 per cent, whereas in the mid-afternoon when convection is an important factor, 37 per cent of the observations lie within 5 per cent, and 61 per cent within 10 per cent of the average. Of the combined a. m. and p. m. observations, approximately 75 per cent lie within 10 per cent of the average.[5] As a usual thing, when convection is most active, the wind speed is low and the resulting error is of little consequence. Nevertheless it is obvious that the accuracy of single-theodolite work will be greatly increased if the observations are taken at the time when convection is least pronounced.

A careful examination has been made of approximately 700 time-altitude curves of two-theodolite observations to determine the effects and extent of convection on individual observations. In general we find convection appreciably affects the ascensional rate only in the lower levels—below 1,500 or 2,000 meters. However, during the summer months and especially at southern stations, the effects are noticeable occasionally to much higher altitudes. The rate of ascent may be either increased or decreased by convection. Table 3 shows the a. m. and p. m. observations classified as to season, no convection, upward convection and downward convection.

TABLE 3.—*Number of observations that showed no convection, upward convection, and downward convection*

Season	a. m.				p. m.			
	No convection	Upward	Downward	Total	No convection	Upward	Downward	Total
Spring	35	1	0	36	24	38	21	83
Summer	68	5	2	75	56	79	44	179
Autumn	94	5	1	100	85	69	22	176
Winter	2	0	0	2	27	7	4	38

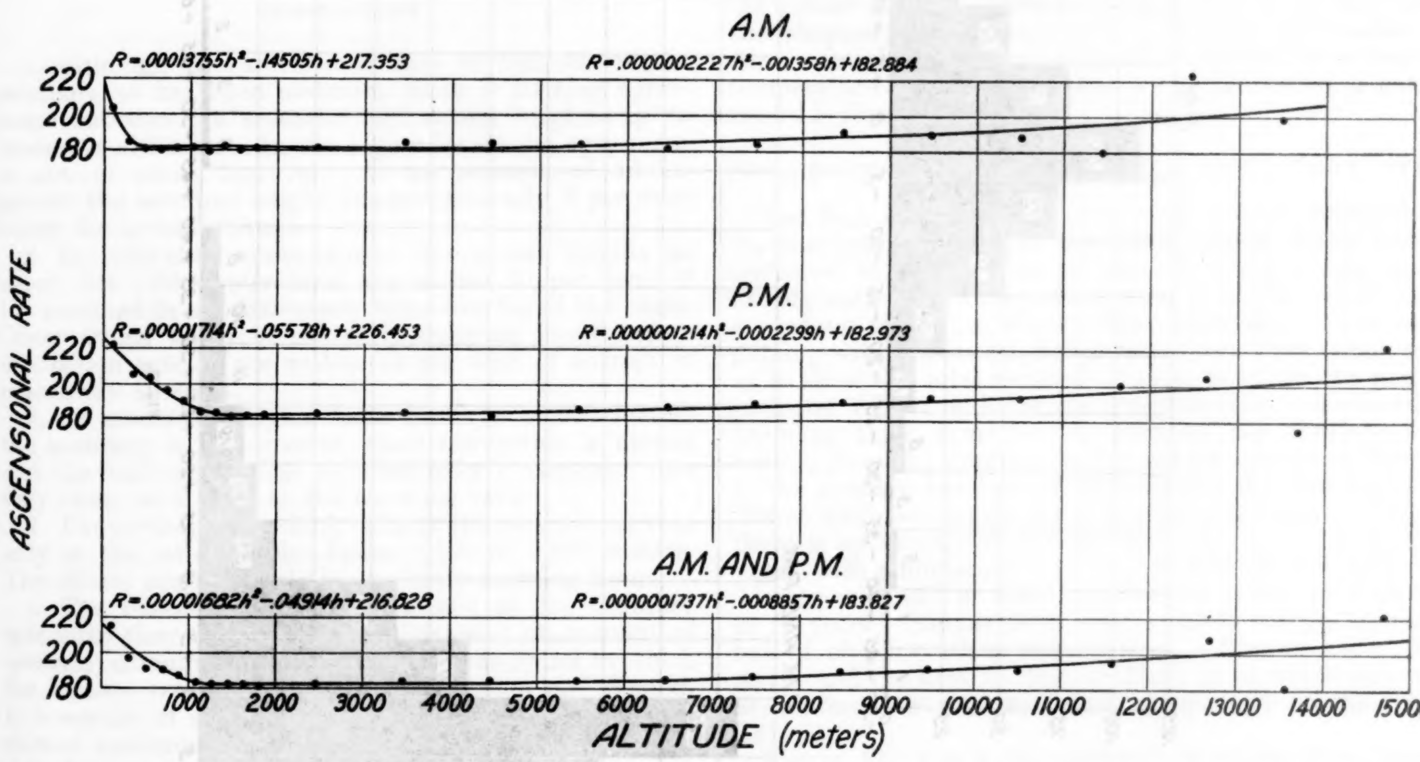

FIG. 2.—Time-altitude curves for the a. m. data (lower solid curve), p. m. data (upper solid curve), and the a. m. and p. m. data combined (intermediate solid curve). The broken curve shows the assumed altitudes.

It will be observed from the table that less than 7 per cent of the morning observations show effects of convection, whereas approximately 60 per cent of the afternoon observations were affected to a greater or less extent. In many cases the effects were not so pronounced as to impair the results materially. The a. m. observations that showed convection to any extent were without exception taken after 8 o'clock. In this connection we mention the fact that the percentage of an error that is caused by convection in the lower levels, becomes less and less with increasing altitude; thus an observation that is in error 25 per cent, or 500 meters in altitude, at the 2,000-meter level, is in error only 10 per cent at the 5,000-meter level, and 5 per cent at the 10,000-meter level, providing the rate of ascent above 2,000 meters is near the assumed.

The percentage of error in the wind velocities of single-theodolite observations caused by convection in

[5] These figures differ slightly from those given on page 25 of the discussion of Dr. Fassig's paper, loc. cit.[4] In that case, however, the variations were from the *assumed* rate; in the present case, they are from the *average* rate. The difference is made clear by reference to Figure 3.

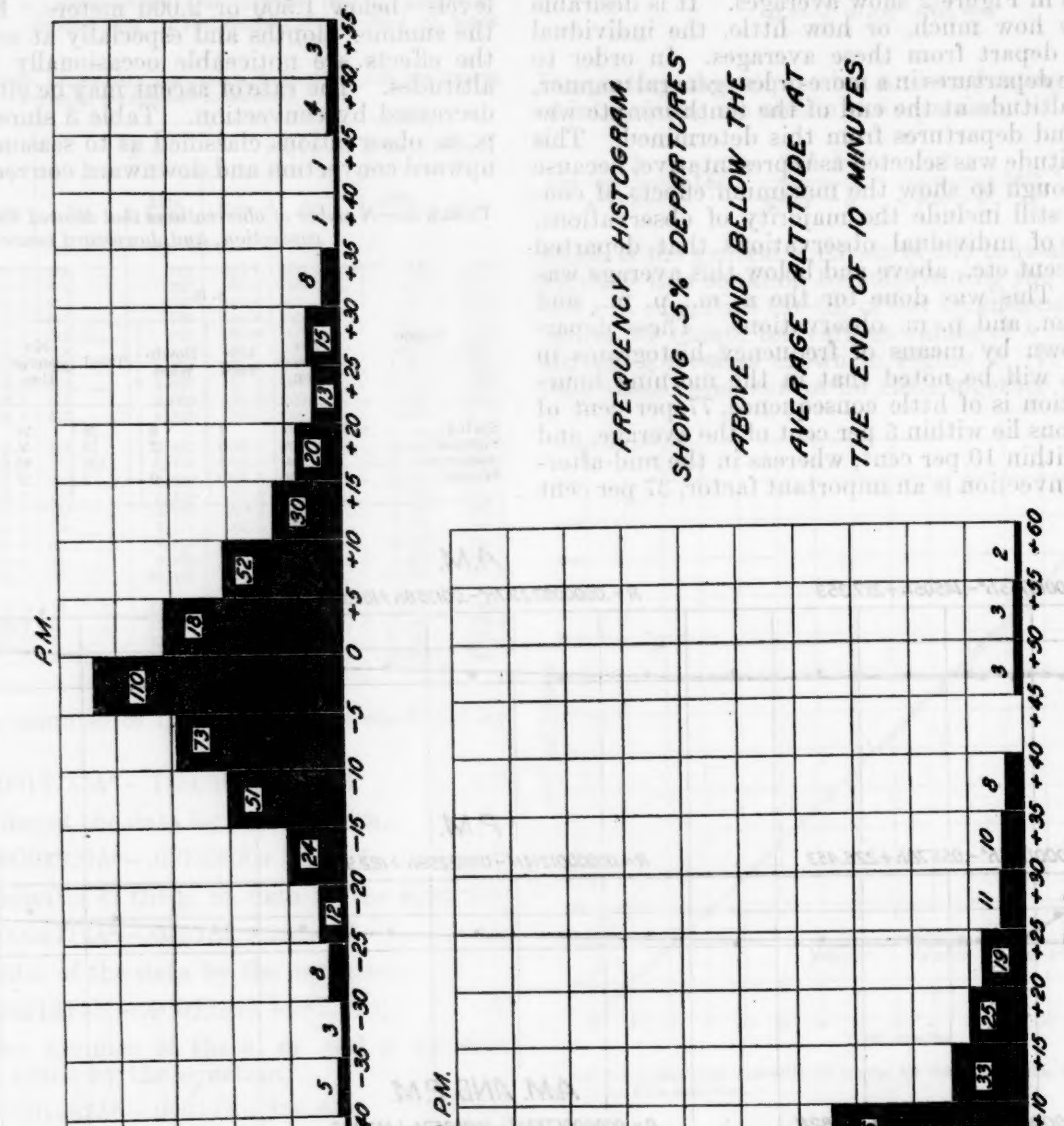
FREQUENCY HISTOGRAM
SHOWING 5% DEPARTURES
ABOVE AND BELOW THE
AVERAGE ALTITUDE AT
THE END OF 10 MINUTES
A.M.
P.M.
A.M. AND P.M.

FIG. 3.

the lower levels is not accumulative, but instead becomes less and less with increasing altitude. In general the percentage of error in the computed velocities is practically the same as that in the assumed altitudes. This is true, however, only when the percentage of error in the assumed altitudes does not change materially from minute to minute as is the case in the higher levels.

Special efforts have been made to determine to what altitude our balloons will ascend. As a rule the observations that reached considerable altitudes ended because of the bursting of balloons, or disappearance on account of distance, haziness or clouds. No cases were found where there was convincing evidence that the balloon reached a state of equilibrium and floated. This is not in accord with the results obtained by British investigators.[6] Our conclusions are based on more than 800 two-theodolite observations, of which more than 50 reached above 10,000 meters in altitude and 1 to an altitude of approximately 15,500 meters.

CONCLUSIONS

1. Although the ascensional rate of balloons is not constant, as has been assumed, there is striking agreement between the assumed and actual heights up to moderate altitudes. In the higher levels the agreement is not so close, however. At an altitude of 15,000 meters the assumed height is approximately 5 per cent below the actual altitude.
2. In individual observations the actual heights at about the 2,000-meter level are within 10 per cent of the assumed in approximately three-fourths of the cases. Observations taken in the early morning hours before convection sets in are within 10 per cent of correct in practically all cases.
3. At moderate heights from 2,000 to 10,000 meters the accuracy is still greater, since convection is absent and the balloons ascend at essentially a constant rate very close, as a rule, to the assumed rate.
4. Convection appreciably affects the ascensional rate only in the lower levels—below 1,500 or 2,000 meters. The effects are negligible in the early morning hours.
5. The balloons continue to ascend at the ordinary rate until they either burst, or disappear on account of distance, cloudiness, etc. No cases were found in which the balloon reached a state of equilibrium and floated. It is worthy of note also that only two or three balloons showed evidence of a slow leak caused by pinholes.
6. As to what takes place above 16,000 meters, we have at present no information. It seems likely, though, that the best balloons continue to rise to perhaps 20,000 meters or more, and that the rate of ascent continues to increase.

Acknowledgment is due to Mr. W. R. Gregg for valuable suggestions and to Mr. Edgar W. Woolard for aid in the mathematical portion of the paper.

[6] Johnson, N. K., Quar. Jour. Roy. Met'l Soc., Vol. XLVII, p. 49.

THE PROBABILITY OF CERTAIN MINIMUM TEMPERATURES IN THE SANTA CLARA VALLEY, CALIFORNIA IN SPRING

By ESEK S. NICHOLS, Meteorologist

[Weather Bureau Office, San Jose, California, March 15, 1924]

The average daily minimum temperature, based on 17-years' records at the Weather Bureau office in San Jose, Calif., is 42.1° for the month of March, 43.7° for April, and 45.9° for May. The lowest recorded in March during the entire period is 30°; in April, 33°; and in May, 35°. On the average, less than 1 day per year in March has a minimum of 32° or lower, tenths of a degree considered; and that minimum has not been reached on any day in April or May during the 17-year period. The average date of the last killing, or very severe frost in spring is February 11; and the latest is March 31. However, frosts of less severity, sometimes sufficient to damage tender vegetation considerably, occur in April and May. Some frost occurs in May in nearly one-half of the years.

The above paragraph contains such minimum temperature and frost data as are usually given in climatological articles. For many purposes, notably in connection with studies of damage to fruit by low temperatures and protection from such damage, more detailed knowledge of the occurrence of low temperatures of different degrees is desired; not only for San Jose but also for other places in the Santa Clara Valley, particularly in the colder sections thereof. This article is written for the purpose of supplying such additional information. Also, a method of increasing the usefulness of a short temperature record taken near a station having a long record is illustrated.

FREQUENCIES OF CERTAIN TEMPERATURES AT SAN JOSE

The first step taken in this study was to determine the number of days in the first half of March (1st to 15th, inclusive) throughout the 17 years of record at San Jose having each minimum temperature from the lowest recorded up to 45°, in whole degree intervals. Then beginning with the lowest, progressive sums were taken, so as to show the total number of days on which the thermometer fell to or below each temperature considered. Dividing these sums by 17, carrying the divisions to tenths, gives the numbers in the second column of Table 1, the average numbers of days during the first half of March with each minimum temperature or lower. Thus, there is an average of 0.1 day per year, or 1 day in 10 years, with a minimum of 30° or lower in the first half of March; with 32° or lower the number is 0.8, or 8 days in 10 years. Similar data were obtained for the second half of March (16th to 31st, inclusive), the two halves of April, and the first 15 days of May, all of which figures are entered in the third and subsequent columns of Table 1.

Figure No. 1 is a line diagram on which have been plotted the data from Table 1, minimum temperatures in degrees as abscissas and average numbers of occurrences as ordinates. For each of the five semimonthly periods considered the resulting curve is roughly a parabola with axis vertical; showing that, for the lowest temperatures in each case, especially the first three or four, increase of frequency with increase of temperature is slower than it is for higher temperatures. Thus, for the fore part of April, increase of frequency from 37° to 38° is much greater than the increase from 33° to 34°. Also, the lower portions of the curves for April, and to a lesser degree that for the latter part of March, are crowded together; showing a comparatively slow decrease in the frequency of very cold days as the season advances. Thus, temperatures of 35° or lower are nearly as numerous in the latter part of April as they are in the first half of that month; and 33° or lower occurs nearly as often in the first half of April as in the second half of March.

MINIMUM TEMPERATURE RECORDS IN ORCHARD DISTRICTS

To determine temperatures in orchard districts, particularly minima, special stations have been maintained at a number of places in the Santa Clara Valley during the springs of 1922 and 1923. The period of observation is not sufficiently long to enable us to find directly the frequencies of various temperatures throughout the valley as we have done in the case of San Jose. But we may compute the probable frequency numbers by an indirect method, which is followed below.

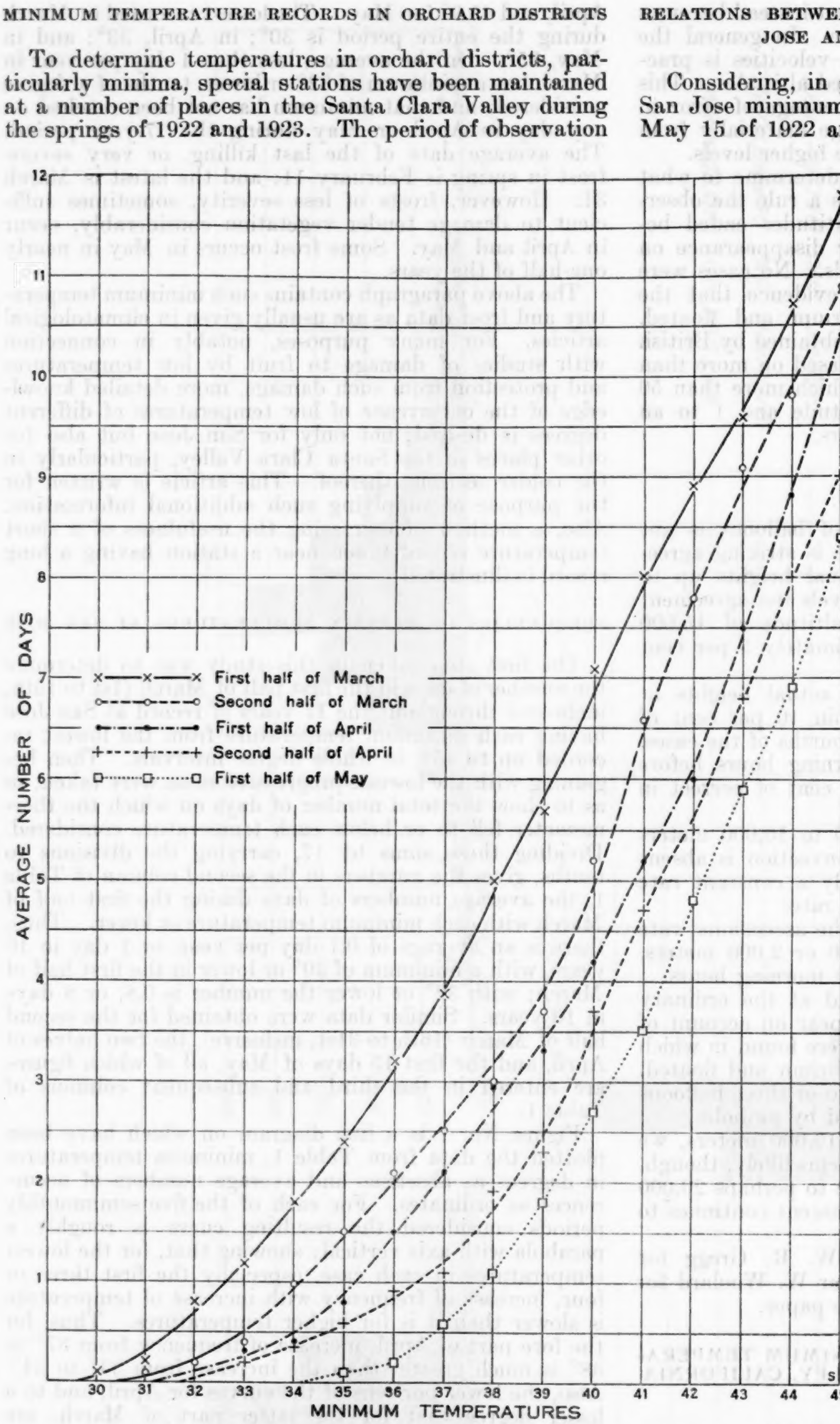

FIG. 1.—Average number of days with certain minimum temperatures during certain periods in spring, San Jose, Calif.

RELATIONS BETWEEN MINIMUM TEMPERATURES AT SAN JOSE AND THOSE AT SUBSTATIONS

Considering, in general, only mornings on which the San Jose minimum was 40° or lower, from March 1 to May 15 of 1922 and 1923, the two springs with substation records, I subtracted each minimum for each substation from the corresponding data for San Jose. In Table 2 are entered, for each station, numbers of cases in which the differences were positive, negative, and zero, the sums of both the positive and the negative differences separately, the average difference, and the highest and lowest differences.

The first 14 stations listed in this table were in operation during both springs of record. Following are 6 additional stations that were maintained during only one season, or a portion thereof; means are of course not so reliable as in the cases of the longer records. Also, at the bottom of the table are data for three cooperating stations located in orchard districts and equipped with the ordinary louvered shelters. The relative locations of the stations are shown on the accompanying map, Figure 2. Also, their altitudes above sea level, taken generally from U. S. Geological Survey topographic maps, are given in Table 2; and a brief description of the topography of the district is contained in my paper entitled "Climate of San Jose, California."* In all except two stations, one on each side of the valley in the foothills, the mean and the most frequent differences are negative; that is, the low minimum temperatures at the time of year we are considering average and are usually lower at the outside stations than at San Jose. Also, differences for the several stations vary considerably. Several reasons may be mentioned as accounting for these differences, especially the following: Topography; distance from San Francisco Bay; the fact that the San Jose thermometers are exposed at a height of 12 feet above ground, whereas the others are at about the 5-foot elevation; the slight effect of the city in raising the minimum at the central station; and the fact that the special station thermometers were exposed in shelters of somewhat more open type than those at San Jose and the three stations listed at the bottom of Table 2.

Further, I plotted on cross-section paper the relations between San Jose minimum temperature and the sub-

* "Climate of San Jose, California," MONTHLY WEATHER REV., October, 1923, 51:509-515.

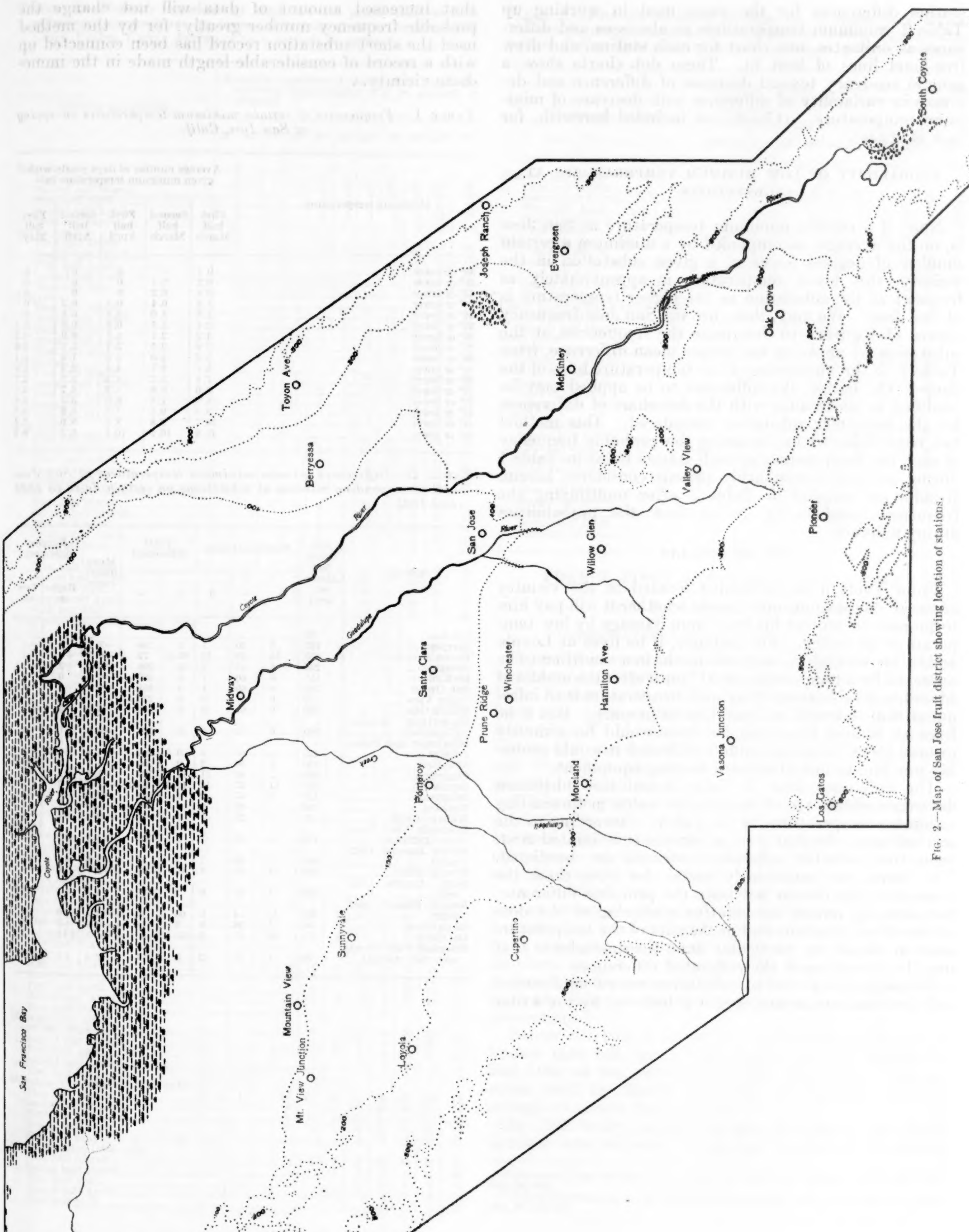

FIG. 2.—Map of San Jose fruit district showing location of stations.

station differences for the cases used in working up Table 2, minimum temperatures as abscissas and differences as ordinates, one chart for each station, and drew free-hand lines of best fit. These dot charts show a general tendency toward decrease of difference and decrease in variability of difference with decrease of minimum temperature. (Charts not included herewith, for lack of space).

PROBABILITY OF LOW MINIMUM TEMPERATURES AT SUBSTATIONS

Now, if a certain minimum temperature at San Jose is, on the average, accompanied by a minimum a certain number of degrees lower at a given substation in the vicinity, this lower temperature is approximately as frequent at the substation as the higher temperature is at San Jose. We may, then, use the San Jose frequency curves of Figure 1 to determine the frequencies at the substation by applying the proper mean difference, from Table 2, to the numbering of the temperature lines of the figure. Or, better, the difference to be applied may be modified in accordance with the dot-chart of differences for the particular substation considered. This method has been followed in obtaining the probable frequency of each low temperature at each station listed in Table 1 during the five semimonthly periods considered herein. Results are entered in Table 3 after multiplying the frequency numbers by 10 to show the probabilities during a decade.

USE OF RESULTS

From Table 3 an orchardist located in the vicinity of one of our stations may decide whether it will pay him to prepare to protect his fruit from damage by low temperatures in spring. For instance, if he lives at Loyola and he knows that his fruit will not be in a condition to be damaged by a temperature of 31° until after the middle of March, our table shows that such temperature is so infrequent that it would not pay him to prepare. But if he lives at Willow Glen and his fruit would be seriously injured by 28° after the middle of March it would probably pay him to install orchard-heating equipment.

The difference data of Table 2 and the substation difference charts are of inestimable value in forecasting minimum temperatures in the valley. According to the method used the San Jose minimum is estimated first, then the probable substation minima are predicted. The charts are particularly useful; for from them the forecaster can obtain not only the probable difference, but also, by noting the relative scattering of the dots at the several stations and in the part of the temperature scale in use at any particular time, the dependence that may be placed upon the estimated differences.

Although the period of substation record used covers only two seasons in any case, it is believed by the writer that increased amount of data will not change the probable frequency number greatly; for by the method used the short substation record has been connected up with a record of considerable length made in the immediate vicinity.

TABLE 1.—*Frequencies of certain minimum temperatures in spring at San Jose, Calif.*

Minimum temperatures	Average number of days yearly with given minimum temperature in—				
	First half March	Second half March	First half April	Second half April	First half May
30° or lower	0.1	0	0	0	0
31° or lower	0.2	0.1	0	0	0
32° or lower	0.8	0.2	0	0	0
33° or lower	1.2	0.4	0.3	0.2	0
34° or lower	1.8	1.0	0.4	0.4	0
35° or lower	2.4	1.5	0.8	0.6	0.1
36° or lower	3.2	2.1	1.5	0.9	0.2
37° or lower	3.9	2.5	2.1	1.1	0.6
38° or lower	5.0	3.0	3.0	1.9	1.1
39° or lower	5.7	3.7	3.3	2.3	1.8
40° or lower	7.1	5.2	4.2	3.7	2.7
41° or lower	8.0	6.6	5.2	4.7	3.5
42° or lower	8.9	7.8	6.0	5.5	4.8
43° or lower	9.6	9.1	7.5	6.8	5.9
44° or lower	10.7	9.8	8.8	8.0	7.4
45° or lower	11.8	10.9	10.4	9.5	8.9

TABLE 2.—*Differences between minimum temperatures at San Jose and corresponding minima at substations on certain dates in 1922 and 1923*

Stations	Altitudes, feet above sea level	Number of cases			Total differences		Mean differences	Range of differences	
		+	−	0	+	−		Highest	Lowest
San Jose	95								
Berryessa	125	0	60	1	0	189	−3.1	0	−7
Toyon Avenue	250	16	29	16	43.5	72	−0.5	+8	−7
Evergreen	235	4	55	2	45	208	−3.3	+2.5	−11
McKinley	155	0	60	1	0	287	−4.7	0	−12
Oak Grove	185	0	60	1	0	301	−4.9	0	−14.5
Valley View	170	0	57	0	0	230.5	−4.0	−0.5	−8
Willow Glen	150	0	61	0	0	360	−5.9	−2	−10
Hamilton Avenue (Campbell)	180	0	56	0	0	267	−4.8	−1	−10
Winchester and Prune Ridge	125	1	60	0	0.5	249	−4.1	+0.5	−12
Moreland	190	0	59	2	0	250	−4.1	0	−8
Cupertino	265	7	40	11	14	109	−1.6	+7	−8
Loyola	210	11	37	12	12.5	83.5	−1.2	+2	−7.5
Sunnyvale	120	2	57	2	4	246	−4.0	+3	−13
Pomeroy	100	1	60	0	1	301	−4.9	+1	−9.5
Midway (1922)	25	2	24	1	7	76	−2.6	+4	−6
Mountain View Junction (1923 only)	130	1	26	2	2	130	−4.4	+2	−12
Vasona Junction (1923 only)	285	2	20	7	2	53	−1.8	+1	−7
Pioneer (1923)	240	3	25	1	17	96	−2.7	+8	−7
South Coyote (1923 only)	280	3	25	0	2	125	−4.5	+1	−10
Joseph Ranch (part 1923)	600	15	4	0	66	15	+2.7	+10	−6
Santa Clara	80	1	46	0	3	113	−2.3	+3	−8
Los Gatos	475	40	15	4	121	30	+1.5	+11	−4
Mountain View (deciduous fruit station)	90	1	56	2	3	171	−2.8	+3	−12

TABLE 3.—*Probable numbers of days in 10 years with certain minimum temperatures, or lower, at certain stations in the Santa Clara Valley, Calif., during certain periods in spring*

Stations and periods	Probable numbers of times in 10 years the following temperatures will be equaled or exceeded										
	25°	26°	27°	28°	29°	30°	31°	32°	33°	34°	35°
Berryessa:											
First half March			1	3	7	12	18	24	31	39	49
Second half March				1	2	5	9	14	20	26	32
First half April					1	3	5	9	15	21	27
Second half April					1	2	4	6	9	12	17
First half May								1	2	6	11
Toyon Avenue:											
First half March						1	3	7	12	18	24
Second half March							1	2	5	10	15
First half April								1	3	5	9
Second half April								1	2	4	6
First half May											1
Evergreen:											
First half March			1	4	8	13	19	26	33	41	51
Second half March				1	3	6	10	15	21	27	33
First half April					1	3	6	10	16	22	29
Second half April					1	2	4	6	9	13	19
First half May								1	3	7	12
McKinley:											
First half March		1	3	7	12	18	24	33	42	54	69
Second half March			1	2	5	9	15	21	28	35	49
First half April				1	3	5	9	16	23	31	42
Second half April				1	2	4	6	9	14	21	35
First half May							1	3	7	15	27
Oak Grove:											
First half March			1	5	11	17	24	32	40	49	58
Second half March				1	4	9	14	20	26	32	39
First half April					2	5	9	15	21	27	34
Second half April					2	4	6	9	12	17	24
First half May							1	2	6	11	18
Valley View and Hamilton Avenue:											
First half March			1	3	8	14	22	31	41	52	64
Second half March				1	3	7	12	19	27	35	45
First half April					1	3	7	14	22	30	39
Second half April					1	2	5	9	13	20	30
First half May							1	2	6	14	23
Willow Glen:											
First half March	1	3	7	14	22	31	43	55	69	79	89
Second half March		1	2	7	12	20	28	36	49	65	78
First half April			1	3	7	15	23	32	42	52	62
Second half April			1	2	5	9	14	21	36	47	57
First half May					1	2	7	15	27	36	48
Winchester (1922) and Prune Ridge (1923):											
First half March			1	5	10	15	22	30	39	49	58
Second half March				1	4	8	12	19	26	32	39
First half April					2	4	7	14	21	27	34
Second half April					1	3	5	8	12	17	24
First half May							1	3	6	11	18
Moreland:											
First half March			1	5	10	17	24	31	39	49	58
Second half March				1	4	9	14	20	25	32	39
First half April					2	5	9	15	21	27	34
Second half April					1	4	6	9	12	17	24
First half May							1	2	6	11	18
Cupertino:											
First half March						1	4	10	17	24	31
Second half March							1	4	9	14	20
First half April								2	5	9	15
Second half April								1	4	6	9
First half May										1	2
Loyola:											
First half March							2	6	11	17	24
Second half March								2	4	9	14
First half April								1	2	5	9
Second half April									2	4	6
First half May											1
Sunnyvale:											
First half March			1	3	7	11	18	27	36	49	62
Second half March					2	5	10	17	24	32	43
First half April					1	3	5	11	18	27	37
Second half April					1	2	4	6	11	17	29
First half May								1	4	11	21
Pomeroy:											
First half March			2	5	11	17	24	32	43	56	69
Second half March				2	4	9	14	20	28	36	49
First half April					2	5	9	15	23	32	42
Second half April					2	4	6	9	14	21	35
First half May							1	2	7	15	27
Midway (1922 only):											
1st half March				1	3	7	12	18	24	32	39
Second half March					1	2	5	9	14	20	25
First half April						1	2	5	9	15	21
Second half April							2	4	6	9	12
First half May									1	2	6
Mountain View Junction (1923 only):											
First half March		1	4	10	17	24	31	39	48	58	69
Second half March			1	4	9	14	20	26	32	39	50
First half April				2	5	9	15	21	27	34	42
Second half April				1	4	6	9	12	17	25	35
First half May						1	2	6	11	18	27
Vasona Junction (1923 only):											
First half March					1	3	7	12	18	24	31
Second half March						1	2	5	9	14	20
First half April							1	3	5	9	15
Second half April								2	4	6	9
First half May										1	2

TABLE 3.—*Probable numbers of days in 10 years with certain minimum temperatures, or lower, at certain stations in the Santa Clara Valley, Calif., during certain periods in spring*—Continued

Stations and periods	Probable numbers of times in 10 years the following temperatures will be equaled or exceeded										
	25°	26°	27°	28°	29°	30°	31°	32°	33°	34°	35°
Pioneer (1923 only):											
First half March			1	3	7	12	19	27	36	48	60
Second half March				1	2	5	10	17	23	32	41
First half April					1	3	6	11	18	27	36
Second half April					1	2	4	7	11	17	26
First half May								1	4	11	20
South Coyote (1923 only):											
First half March				1	3	7	14	22	31	43	55
Second half March					1	2	6	13	20	28	36
First half April						1	3	7	15	23	31
Second half April						1	2	5	9	14	21
First half May									2	7	15
Joseph Ranch (March 1923 only):											
First half March											1
Second half March											0
Santa Clara:											
First half March				1	3	7	12	18	24	31	39
Second half March					1	2	5	9	14	20	26
First half April						1	3	5	9	15	21
Second half April						1	2	4	6	9	12
First half May									1	2	6
Mountain View (decided fruit station):											
First half March				1	3	7	13	20	28	38	49
Second half March					1	2	6	11	18	25	32
First half April						1	3	6	12	19	27
Second half April						1	2	4	7	11	17
First half May									1	5	11
Los Gatos:											
First half March									1	3	7
Second half March										1	2
First half April											1
Second half April											1
First half May											0

FOREST FIRES AND STORM MOVEMENT[1]

By E. F. McCARTHY, Silviculturist

[Appalachian Forest Experiment Station, U. S. Forest Service]

A study of weather in relation to forest-fire hazard was carried on during the usual fire season from October 15 to November 30, 1923. Weather data were obtained from the United States Weather Bureau station at Asheville, N. C., and fire records from the national forests of western North Carolina and eastern Tennessee, and from the district fire warden for the mountain district of North Carolina.

While the purpose was to determine the feasibility of predicting periods of fire hazard two or more days in advance, the data collected have made possible the comparison of the current season with the fall season of 1922, for which records were obtained last year.[2]

In the fall of 1922 a season of severe forest fire hazard was experienced throughout the Southern Appalachians from the last week in October to about the end of November. The fire season of 1923 was of much shorter duration and of medium severity for about 15 days. A detailed discussion of these two seasons will make clear the value of weather information as a factor in fire protection.

Before entering a discussion of weather it should be known that fall fires in this region are fed largely by leaf litter of the current year and only minor fires can occur until the leaves are down in quantity and dry enough to create fuel for a fire.

In 1922 a dry period through September and early October was followed, beginning October 5, by heavy

[1] Presented at the meeting of the Society of American Foresters, Baltimore, Md., Dec. 28, 1923.

[2] "Forest Fire Weather in the Southern Appalachians," MO. WEATHER REV., April, 1923, 51; 182-185.

rains. These continued frequently until October 23. About half of the leaf crop was down during the last week of October, which would have been the most severe fire period of the season had all the leaves been down and dry. Rains during November were very light and infrequent. The first seven days of November were days of high humidity and the falling leaf crop did not dry out seriously. No rains had packed this leaf litter, which was loose and deep. Beginning November 8, fires were practically continuous until November 27, except during three days of high humidity and light rainfall. From the 8th to the 15th and from the 20th to the 25th two periods of severe hazard resulted from the looseness of the litter and from weather conditions favorable to fire.

This first period of fire hazard began on November 8, when a storm centered over southern Ontario was passing eastward. This induced northwest winds with a rising barometer and fall in vapor pressure. These winds, coming from the interior of the continent and warming as they move southward, are usually low in humidity, a condition which is increased by the downward convection of cold air in the high pressure zone which warms as it approaches the surface. After the passing of this storm high pressure continued to the northwest of the mountains for two days and remained over the Appalachian Plateau until November 15, when it moved northeastward and gave place to a storm which had first appeared over Oregon on November 6. Rain on November 15 checked the fires. This period of dryness was due to a high-pressure zone which, after the usual approach from the northwest, remained over the Southern Appalachian region. The storm which brought relief on November 15, had moved from Oregon to Texas, then up the Mississippi Valley and out over lower Canada. It was followed by high pressure and dry weather for two days, which induced more fires. Another well-developed storm moved east from Montana, bringing south winds and a trace of rain on November 20, when the advance of a broad, flat zone of high pressure ushered in a severe period of seven days of fire.

This period was marked by continuous high pressure over and west of the Appalachians. One storm passed across the United States during this time, but the intervening high-pressure zone to the south prevented Gulf winds from affecting the Appalachian region. On November 26, due to lessened pressure in the Mississippi Valley, a low-pressure zone moved in from the region of Montana and brought a snowfall in the Appalachians. This effectively checked serious fires for the season, since storms became more frequent and soon took on the size and intensity of the winter type.

Before leaving the discussion of the 1922 fall season, it should be noted that the active fire season showed only one instance of barometric pressure below 30 inches (corrected to sea level)and that the temperature fell gradually throughout November, giving lower absolute humidity.

The active fall-fire season of 1923 covered about 15 days from November 9 to November 22, a period which was broken once by a light fall of snow. In contrast to the previous year, the fall of 1923 was dry until October 18, but from this time storms were frequent and irregular in movement throughout the season, except for the 15 days mentioned. The leaf crop came down slowly, some of it being whipped off by storms in a partially green state. The frequent rains previous to November 8 had compacted the litter and prevented its drying.

A severe drop in temperature followed two Gulf storms which swept the eastern States toward the end of October. The first traveled nearly due north from the Gulf to the Great Lakes and a second moved north along the Atlantic coast, thereby increasing the depression of temperature and causing a snowfall in a portion of the mountain region. This snowfall, due to the mechanical breaking off of green leaves and the low temperatures which followed, was favorable to fire prevention. A third Gulf storm brought precipitation and passed to the northeast on November 8. From then until November 22 the mountain region was under the influence of a high-pressure zone, but during the time one storm passed across the Lakes and caused a light precipitation without a marked fall in barometer. The dry period was finally broken by a storm which passed from the southwest to the region of the Great Lakes.

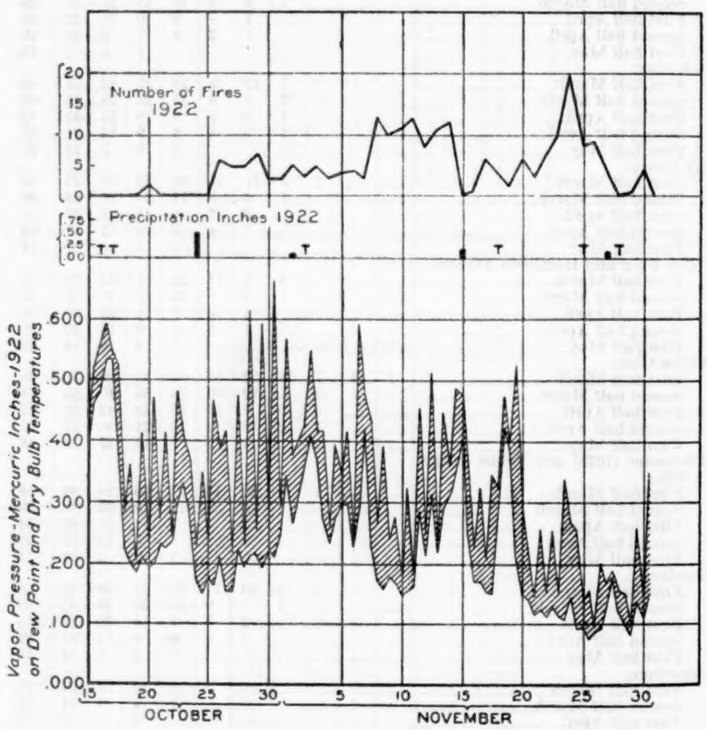

FIG. 1 - RELATION OF FIRES TO PRECIPITATION AND VAPOR PRESSURE, 1922

The entire period of six weeks during which fires usually occur was marked in 1923 by irregular movement of storms and by predominance of southern winds which brought moisture from the Gulf and Atlantic. During November there was an upward rather than downward trend of temperature and a generally lower range of barometer than in 1922.

In this brief record of storm movement during these two fall-fire seasons, periods of fire hazard are seen to coincide with instances of high pressure over the Mississippi Valley and Appalachian Plateau. During the average cycle of storm movement, in which storms appear successively at intervals of three to five days, the Appalachian region does not remain long enough under a high pressure zone to undergo the most severe type of fire hazard. From one to two days are needed to dissipate the moisture brought by a rain or snow storm. To produce very dry conditions, therefore, either a stagnation of storm movement must take place in such a way as to leave a high zone over the Appalachian region or there

must be a continuation of high pressure accompanying the movement of storms across the country to the north. Instances of both kinds occurred during the two seasons reviewed.

The logical conclusions of the study of two fire seasons are summarized as follows:

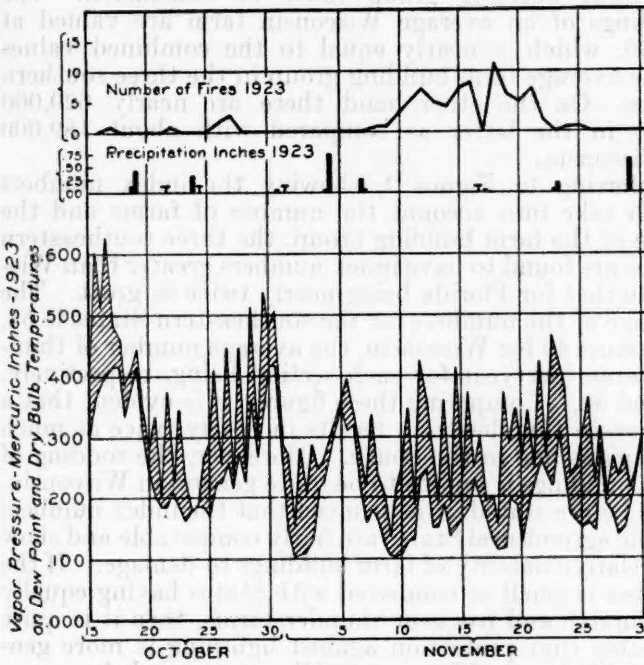

FIG.2 - RELATION OF FIRES TO PRECIPITATION AND VAPOR PRESSURE, 1923

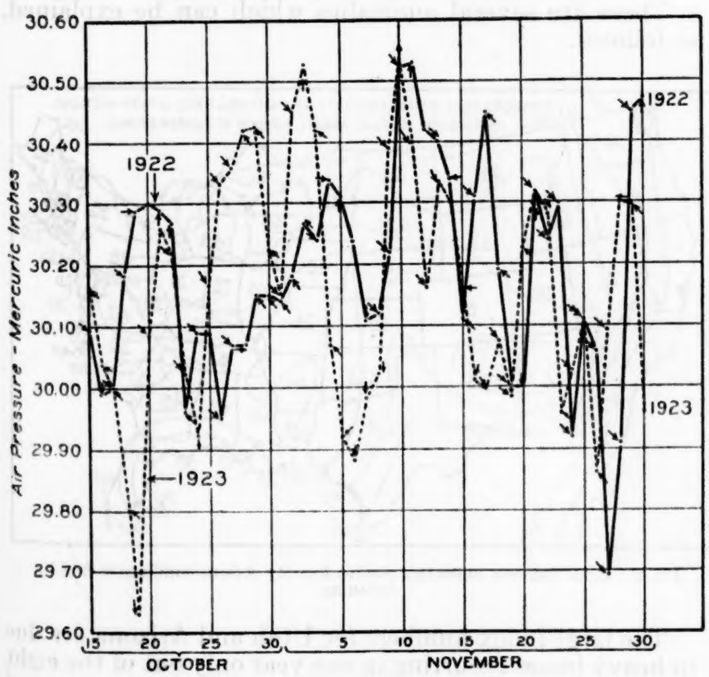

FIG.3 - AIR PRESSURE IN 1922 AND 1923
(Arrows Indicate Wind direction)

1. Weather conditions are of minor importance until the leaf crop is down.

2. Heavy rains which pack the leaf litter retard its drying and make fire control easier.

3. Dry periods occur after the passing of storms and with the advent of high pressure. This induces winds from the interior of the continent, which are dry; it brings lower temperatures, clear days, and lower absolute humidity. Day temperatures are high in spite of heat lost by radiation at night. The large diurnal range of temperature makes relative humidity low at midday.

4. The Appalachian Plateau, by reason of its altitude and consequent radiation of heat, tends to induce a downward movement of air and retain high pressures.

5. Disturbances which displace the pressure conditions in times of severe fire hazard commonly advance over Montana or Texas and the Gulf. Storms of the latter type are less frequent in the late fire season.

6. The weather data collected daily by the Weather Bureau at Washington is broad enough to indicate such disturbances and the rate of movement with sufficient accuracy to forecast them at least three days in advance. This is not a marked departure from present Weather Bureau practice, since general weekly forecasts are now issued by this Bureau.

The undertaking of forecasts for the specific purpose of aiding in forest-fire control will further research in this line and result in a concerted effort to increase the usefulness of such a service. Studies of storm movement at times of great fire hazard as shown by fire records will furnish the experience needed to fix the paths of storms during the brief periods involved.

Field research should furnish a more accurate measure of successful prediction than chance fires by a study of the factors controlling leaf fall and the rate of drying of litter under varying conditions of the atmosphere.

LIGHTNING FIRE LOSSES [1]

By ROY N. COVERT, Meteorologist

As an introduction to the subject it is desired to state that while it is known that the Weather Bureau of necessity has carefully studied the thunderstorm and its phenomena both from the physical and climatic aspects, many do not realize that for more than 30 years this Bureau has been an earnest advocate of the protection of buildings and other property against lighting by suitable rodding. Amongst its literature will be found bulletins on protection appearing as early as 1894, and as an outgrowth, the Bureau is frequently called upon to advise inquirers concerning the proper methods and materials to be employed. Occasionally plans are drawn up in detail for the protection of Government structures, as for example the White House, which was rodded in 1910 after plans and specifications prepared by Professor Marvin.

The object of the study presented in this paper was to determine the relative liability of farm buildings to fire damage by lightning. This object has been reached only approximately and in part because of the nature and insufficiency of the available information, but there is enough of interest it is believed to merit consideration.

Following is a brief discussion of the data employed:

1. The annual lightning-fire losses by states for the years 1915 to 1922, both years inclusive, from which a yearly average was obtained, were furnished by the National Board of Fire Underwriters. These figures, given in dollars, represent all the losses reported by their Actuarial Bureau, and an additional 25 per cent estimated by them to cover unreported losses. Changes in value from year to year are taken into account in estimating losses.

2. The number of farms in each State reported in the 1920 census. A farm is defined as "all the land which is

[1] Presented before the American Meterological Society at its meeting in Washington, D. C., April 1924.

directly farmed by one person conducting agricultural operations." Tracts less than three acres are not farms unless products valued in excess of $250 were produced in 1919, or its operation required one person's continuous service.

3. The average value in dollars of the buildings per farm for each state as reported in the 1920 census. These figures are estimates of their value at the time of the census, and are not replacement values. They do not include buildings used for manufacturing purposes.

In an agricultural State such as Iowa the lightning-fire losses in the rural districts are found to be about 75 per cent of the total. This percentage would not be the same in a State like Massachusetts, but being unable to learn what it is, and for the sake of comparison, the farm building losses in each State were assumed to be the same part of the whole, i. e., 75 per cent of the total, or approximately 90 per cent of the reported losses, which, as before stated are increased by 25 per cent to cover unreported losses.

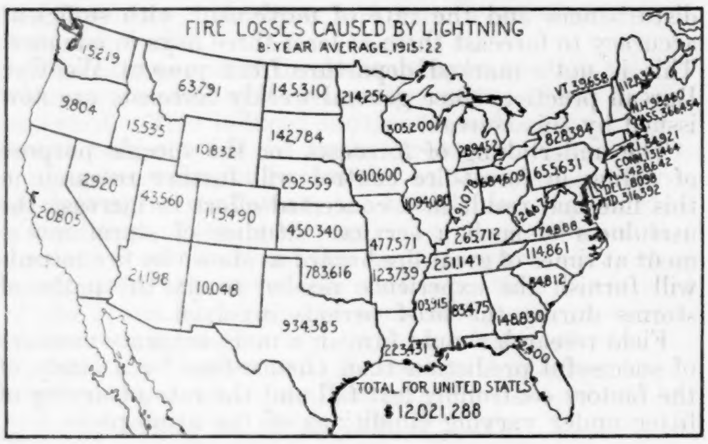

FIG. 1.—Average annual fire losses caused by lightning

The estimated total farm building loss was next divided by the number of farms per State giving the loss per farm, and finally the ratio of the loss per farm to the average value of the farm buildings per farm in each State was computed. This number is an index, in the agricultural States at least, of the relative liability of the farm buildings to fire damage caused by lightning.

Taking Alabama as an example, the average annual reported loss was $66,780; nine-tenths of this, $60,102, is the estimated farm building loss; dividing by the number of farms, 256,099, the loss per farm was $.235, and the ratio of the loss per farm, $.235, to the average value of the farm building group, $499, is .00047; i. e., 47 is taken as the index number.

The average annual losses for the several States are shown in figure 1. The average annual loss for the whole United States is a little over 12 millions of dollars, which is probably a conservative figure. Illinois has the unenviable first place with an average annual loss of over a million dollars, undoubtedly due in large measure to the firing of farm buildings which are numerous and valuable, but also because of losses in the industrial sections. Texas is next in order because of its large area and the presence of highly inflammable oil-storage tanks. New York is third, its heavy losses being attributed to the same reasons given for Illinois. In general the highly developed agricultural States suffer heavy losses, as do likewise the thickly-populated industrial States of the northeast. The more destructive effect of the cyclonic thunderstorm is in evidence. For example, the combined losses in the States of Florida, Georgia, and Alabama, where the average annual number of thunderstorms, many of the so-called heat type, is nearly 75, amounts to $284,705, or less than the loss in Wisconsin alone, where the number of thunderstorms is about 30 per year. However, the number of farms and the average value of the farm building group must be considered. The buildings of an average Wisconsin farm are valued at $3,006, which is nearly equal to the combined values of the average farm building group in the three southern States. On the other hand there are nearly 620,000 farms in the latter as compared with about 189,000 in Wisconsin.

Referring to Figure 2, showing the index numbers which take into account the number of farms and the value of the farm building group, the three southeastern States are found to have index numbers greater than Wisconsin, that for Florida being nearly twice as great. The average of the numbers for the southeastern States is 55, as against 40 for Wisconsin, the average number of thunderstorms per year for each section being, respectively, 75 and 30. Comparing these figures, it is evident that a Wisconsin thunderstorm results in nearly twice as much damage as one in the South. Moreover, the rodding of farm buildings is known to be quite general in Wisconsin.

As before stated, it is believed that the index numbers for the agricultural States are fairly comparable and show the relative liability of farm buildings to damage. If the number is small as compared with States having equally destructive and frequent thunderstorms, then it is quite probable that protection against lightning is more general. Michigan, Wisconsin, Minnesota, and Iowa are States where it is estimated that somewhat more than half of the farm buildings are protected by rodding.

There are several anomalies which can be explained, as follows:

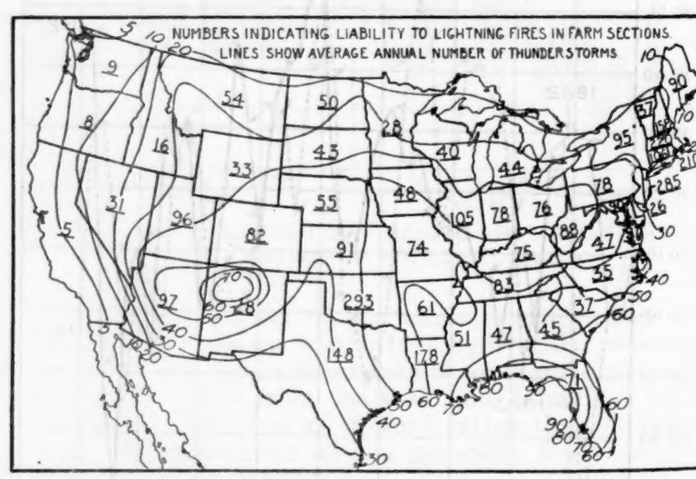

FIG. 2.—Index numbers indicating relaiive liability of farm buildings to fires by lightning

The large index numbers for Utah and Arizona are due to heavy losses occurring in one year only out of the eight for which data are available; a greater length of record would reduce the average per year.

Excessively large index numbers for Oklahoma, Texas, and Louisiana are due to the inclusion of the costly oil-tank fires in the total losses. It has not as yet been possible to separate these from the losses on other property.

In the industrial States of New York, New Hampshire, Massachusetts, Rhode Island, Connecticut, New Jersey, and probably Illinois, the index numbers are large because the rural losses are less than the assumed 75 per cent of

FIG. 1.—Funnel cloud in tornado of May 3, 1922, at Northfield, Minn. (Photograph by Martin N. Ayre.)

FIG. 2.—Funnel cloud in tornado of May 3, 1922, at Northfield, Minn., about 7 p. m. (Photograph by Paul J. Orebo.)

the total losses. Very destructive lightning fires occasionally occur, as, for example, the million-dollar elevator fire in Baltimore in 1922.

Before these index numbers can be fully interpreted, information should be available giving accurately the proportionate losses occurring in town and rural sections, and, probably more important, it is desired to know what percentage of the total number of farm buildings in each State is protected against lightning by rodding. Such information could be included in the next census.

TORNADO OF JUNE 22, 1923, AT FORT YATES, N. DAK.

By A. McG. BEEDE

On June 22, 1923, about 5 p. m., at Fort Yates, N. Dak., it was raining lightly and thundering, breeze southwest. My son called my attention to certain clouds about five miles away, up high, very black, and thrusting downward something shaped like a huge fan, wide end upward in the clouds. The clouds were slowly circling around and slowly moving northeastward (and so nearer to Fort Yates). This continued for 10 minutes, while the cloud mass had moved forward about three miles, and meanwhile the downthrust, always fan-shaped, had been made a dozen times and then taken up into the cloud. None of these downthrusts had reached the earth, though each one created wind disturbances under it on the earth.

Then a streaming, gray downthrust very rapidly extended nearly to the earth, about two miles southwesterly from Fort Yates, and there was great disturbance on the earth under it. In a moment it was lifted again, although the cloud mass had not lowered at all between clouds and sunshine. This was repeated three times while the cloud mass was rather slowly circling around and moving northeasterly. These three downthrusts were one minute apart.

Just then a streamer extended quickly to earth, about 1½ miles from Fort Yates. It was a slender streamer, light gray in color. As it touched the earth there arose around it a funnel-shaped vortex, very small on the earth and enlarging at an angle of about 15 degrees, whirling around more slowly than some others I have seen; the funnel arose about 200 feet above the earth, while in its center and extending upward to the high clouds, the streamer could be seen, the cloud still circling around and moving northeasterly toward the cloud over the Missouri River. Then this slight streamer was taken up into the cloud with the vortex following it, and disappeared. All this had been done in about one-fourth of a minute.

The vortex pulled up bushes and grass and some dirt, and spewed this material over an area many times wider than the vortex. The next downthrust, half a minute later, was larger and as rapid, reaching the earth about 300 yards onward from the last thrust mentioned. Its behavior, funnel and all, was like its predecessor, only more forceful. Then came a third thrust to earth, in a large bunch of bullberry trees, some of them 4 inches in diameter and deeply rooted, and it pulled them all up by the roots like weeds, drawing them up in the funnel, whence they were spewed out. This funnel was 300 to 500 feet high, but still the angle of the sides was about 15 degrees. There were nine more downthrusts to the earth in rapid succession, while the upper cloud did not lower at all, but kept on a level with the great cloud it was approaching.

Finally, the tornadic cloud reached the great cloud, which was moving up river all the time very slowly, and just as this happened, a last streamer was thrust halfway down to the earth, just westerly from the Congregational mission, and under it barrels and unsawed poles and all movables went whirling around and abroad in every direction. It was thundering near and heavy all of the time, but I saw no lightning, and there was not much rain, but a few scattering drops only, and the surface of the earth was rather dry, though just below the surface it was saturated with water. As the two clouds merged the combined cloud mass quickening its slow movement, moved up river, away from the river north by a little westerly over the old town of Fort Yates, and over St. Peter's church. At about this time there was another tornado over west in Grant County.

As the next to last full streamer went down numerous crows appeared in the vortex and were whirled around, but I did not see any of them fall, nor were dead crows there later. I did not see the crows fly *into* the vortex, but saw them about 100 flying and twirling *in* it. Perhaps they were taken up from where they had taken refuge, in a bunch of bushes.

There was no damage, because nothing was in the tornado's path to be damaged.

Old Indians claimed that whenever there is a whirlwind on the earth tossing leaves and grass and dust, there is a ghost-like streamer from on high which the eyes of some persons can see. They called this streamer "Amakpiya—ta nagi clouds—ghost)."

EDITOR'S NOTE.—The rather faintly developed tornado described by Mr. Beede occurred in the southern quadrant of a cyclonic system centered at 8 a. m. 75th meridian time over Manitoba; its entire southern half was a region of thunderstorms and squall winds. Mr. Beede describes what apparently was a tornado of slight intensity that developed in the general storm area.

TORNADO AT NORTHFIELD, MINN., MAY 3, 1922

By U. G. PURSSELL, Meteorologist

[Weather Bureau Office, Minneapolis, Minn.]

A small tornado of little violence apparently developed a short distance west of Northfield about 7 p. m. May 3, pursued a path approximately in a northeast direction, about 4 miles in length, and disappeared soon after crossing the hill upon which St. Olaf College of Northfield stands. The damage was confined to the wrecking of small farm buildings, barns, and garages.

The funnel cloud was seen by a number of people in Northfield and was photographed by several persons. We are indebted to Mr. Martin N. Ayre and Mr. Paul J. Orebo respectively, for the two prints reproduced in Figures 1 and 2 below. Unfortunately the details of the two views are not known, the first named (Fig. 1) was evidently made from a point nearer to the funnel cloud than the second. Both photographs must have been made about 7 p. m. The photograph by Mr. Ayre was taken at one-quarter to one-third mile; Mr. Orebo's was more distant.

IS THE ACCURACY OF PRECIPITATION MEASUREMENTS DEPENDENT UPON THE AREA OF THE RECEIVER OF THE GAGE? [1]

F. LINDHOLM

[Meteorologische Zeitschrift, September, 1923.]

The extent to which the area of the receiver affects the accuracy of precipitation measurements has been studied in detail for German precipitation conditions by Hellmann.[2]

From these observations it developed especially that the amount of precipitation from gages with receiver areas of 500 to 1,000 cm.^{2} would under similar conditions be measured with similar accuracy.

With respect to the construction of various rain-gages it should be especially noted that the ratio between wetted perimeter and the receiver areas is the same. The size of the aperture angle of the funnel is also of importance.

During the cold snow season the Hellmann observations also show no great differences between amounts of precipitation deposited in gages with receivers of different areas.

As it is of practical importance to use a smaller and lighter gage for an intensive concentration of groups of precipitation stations, comparative measurements were undertaken during the last year between the old Swedish rain gages of 1,000 cm.^{2} receiver area and a smaller one of 200 ^{2} cm., mainly of the Hellmann type, at several Swedish stations under very different climatic conditions. The question at issue was whether a smaller rain-gage is suitable for the varying conditions of Swedish precipitation.

Following I present a brief account of the results thus far obtained. Of the Swedish gage of 1,000 cm.^{2} receiver area (for details of this see H. E. Hamburg, Les Pluies en Suède, 1860–1890, Appendix aux Observ. Meteor, Suedoises, vol. 52, 1910), the ratio V, between wetted perimeter and receiver area, is very suitable, $V=3.0$. In this respect the large gage is superior to the original Hellmann one in which $V=7.5$; otherwise, under similar conditions, a more satisfactory result should be expected from the large Swedish gage, especially in regard to smaller amounts of precipitation.

To diminish the loss through wetting in the smaller gage, I have employed a movable funnel, 15 cm. below the upper rim of the gage, during the warmer period of the year. The ratio, V, therefore becomes reduced to $V=5.0$. The measurement of the precipitation in the smaller gages is accomplished by the aid of cylindrical measuring glasses graduated to 0.1 mm. The direct error in measurement with either one or the other gage arising from inaccuracy of the selected receiver and the graduation of the proper measuring glass can not, as control measurements have shown, exceed 10 per cent.

In Table 1 are combined the monthly sums of precipitation by both gages at the two experiment stations, Lund ($\varphi=55°\ 37'$, $\lambda=13°\ 2'$ east of Greenwich), and Abisko ($\varphi=68°\ 21'$, $\lambda=22°\ 30'$ east of Greenwich). At Lund, the southerly station, there was only a small difference between the two gages, as at this station they were freely exposed without shielding device, as they usually were at the Swedish stations previously. (See H. E. Hamburg, l. c.) The comparative measurements at this station are therefore comparable with those of Hellman, and also with respect to the climatic relations. In conformity with the Hellmann results there is also a small excess for the smaller rain gage during the snow season. This appears plainly in Table 2.

TABLE 1.—*Precipitation in millimeters*

	Lund, 1921			Abisko, 1921		
	Receiver area, cm.^{2}			Receiver area, cm.^{2}		
	1,000	200	Difference (per cent)	1,000	200	Difference (per cent)
	Without shield			With shield	Without shield	
January	83.4	86.2	+3.4	26.6	22.3	−16.0
February	21.0	21.9	+4.3	23.6	18.6	−20.9
March	21.5	21.3	−0.9	13.5	11.0	−18.6
April	24.4	25.2	+3.3	16.9	15.6	−7.7
May	19.5	19.4	−0.5	45.8	41.2	−10.0
June	64.3	62.1	−3.4	70.6	69.3	−1.9
July	42.5	42.5	0.0	52.5	50.9	−3.0
August	101.7	99.7	−2.0	111.3	107.6	−3.3
September	47.3	46.3	−2.1	23.2	21.9	−5.7
October	58.8	58.7	−0.2	41.8	42.1	+0.7
November	42.1	42.7	+1.4	13.1	12.4	−6.1
December	94.0	97.4	+3.6	11.3	10.8	−4.5
Year	620.5	623.4	+0.5	450.2	423.7	−5.9

	Lund, 1922			Abisko, 1922		
	Receiver area, cm.^{2}			Receiver area, cm.^{2}		
	1,000	200	Difference (per cent)	1,000	200	Difference (per cent)
	Without shield			With shield	Without shield	
January	33.3	34.2	+2.7	4.9	4.0	−18.0
February	23.4	24.0	+2.6	10.4	10.4	0.0
March	51.0	53.5	+5.0	4.6	4.8	+4.3
					With shield	
April	42.9	43.2	+0.7	9.4	9.6	+2.1
May	18.2	18.2	0.0	13.5	13.9	+3.0
June	62.9	61.0	−3.0	84.0	83.7	−0.4
July	92.5	87.4	−5.5	26.3	26.4	+0.4
August	77.1	73.9	−4.2	44.3	44.6	+0.7
September	87.7	84.2	−4.0	14.7	14.8	+0.7
October	26.6	25.0	−6.0	16.9	16.9	0.0
November	37.8	37.2	−1.6	35.1	36.4	+3.4
December	54.5	51.7	−5.1	13.4	15.1	+11.1
Year	607.9	593.5	−2.4	277.5	280.6	+1.1

TABLE 2.—*Precipitation in millimeters*

	Rain			Snow		
	Receiver area, cm.^{2}			Receiver area, cm.^{2}		
	1,000	200	Difference (per cent)	1,000	200	Difference (per cent)
Lund, 1921, January to December	521.6	519.5	−0.4	98.9	103.9	+5.1
Lund, 1922, January to December	523.3	507.5	−3.0	84.6	86.0	+1.6
Total	1,044.9	1,027.0	−1.7	183.5	189.9	+3.9

	Lervik (island of Jungfrun)		
	Receiver area, cm.^{2}		
	1,000	200	Difference (per cent)
1920–June 30, 1923	25.8	26.5	+2.7
July, 1923	46.7	47.6	+1.9
August 1 to 20, 1923	22.7	23.4	+3.0
Total	95.2	97.5	+2.4

[1] Translated from the German by H. C. Frankenfield.

[2] G. Hellmann, Observations of rain gages of different construction. (Abhandl. des Konigl. Preuss. Meteorol. Inst. 1. Bd. Nr. 3, Berlin, 1890.)

The fact that the smaller rain gage catches a little less rain during the summer months may be explained by the unsatisfactory ratio between wetting and the receiver areas. Nevertheless, it appears to be more probable that this difference is dependent upon the dissimilar exposure of the two gages. This is also indicated by a simultaneous series in the summer of 1920, one at Lervik (Table 2), by Herr Dr. E. de Rietz, during a botanical expedition to the Island of Jungfrun in Kalmarsund, the other by Herr R. Smedburg, first State hydrographer, on the west coast of Sweden.

The series of observations at Abisko show, on the contrary, great differences during the winter of 1921, in that the small gage caught a considerably smaller quantity of precipitation. With respect to this it may be remarked that the large gage from its original exposure was equipped with the shield mentioned heretofore, while the small gage was exposed freely. The effect of wind protection is significantly shown in the series of H. E. Hamburg [3] at Sarna, previously given. Table 3 gives a comparison of the same.

TABLE 3.—*Average precipitation in millimeters, Sarna, 1907–1910*

[According to comparative measurements with Swedish gages, with and without shields]

	January	February	March	April	May	June	July	August	September	October	November	December	Year
Without shield	16.6	11.3	21.5	21.9	36.0	55.0	60.0	66.0	43.5	57.7	11.5	24.6	425.6
With shield	20.7	17.4	27.2	29.9	40.6	56.6	61.5	68.4	44.6	59.6	14.8	32.3	473.6
Difference (per cent)	−20	−35	−21	−27	−12	−3	−2	−4	−3	−3	−21	−24	−10

When these results are compared with the present series of observations at Abisko, it appears that the entire difference in the Abisko series of 1921 arises from the effects of the wind shield of the larger gage. The comparison of the smaller gage without shield with the larger one with shield affords under these hypotheses an insight into the effect of the wind movements.

Table 4 shows how the differences are apportioned to different wind velocities. During summer rains the difference is very small, and no variation with wind velocity is found The shield effect during the warmer portion of the year is therefore without moment. During snowfall the shield exerts such a decided influence that it becomes more effective with increasing wind force up to a certain critical force. Thereafter the effect of the shield appears to diminish rapidly. This may possibly be due to the stronger turbulence induced by the higher wind velocity which could not diminish the wind force to any extent.

TABLE 4.—*Abisko, 1921*

(Depth of precipitation in millimeters]

Wind velocity at height of 15 m.	Snow: Number of days	Snow: Receiver area, cm.² 1,000	Snow: Receiver area, cm.² 200	Snow: Difference in per cent	Rain: Receiver area, cm.² 1,000	Rain: Receiver area, cm.² 200	Rain: Difference in per cent
0 to 4 m. p. s	26	36.2	34.2	−8	93.8	92.0	−2
5 to 9 m. p. s	28	28.2	25.2	−10	134.2	130.2	−3
10 to 14 m. p. s	21	52.4	42.4	−19	62.2	61.1	−2
Above 14 m. p. s	19	43.3	38.2	−12	----	----	----

[3] H. E. Hamburg. l. c. Page 13.

From March, 1922, the 200 cm² rain-gage at Abisko was equipped with a shield of the same reciprocal dimensional proportions as the larger one. Since that time the monthly sums, as well as those of the winter months (Table 1), show very similar values, much the same for one gage as for the other. The entire precipitation from April to December, 1922, differs only about 2 per cent, and even shows a higher result with the 200 cm.² gage.

That the same close agreement likewise prevails for snowfall if both gages are equipped with protecting shields, is evident from the comparison in Table 5. While the total difference for the snow fall before the installation of the shield on the smaller gage, was as much as −12 per cent, it here even passes over into a small positive value.

TABLE 5.—*Abisko*

Character of precipitation	Rain gage, receiver area, cm.²	Total precipitation in mm., 1921, to Mar., 1922	Rain gage, receiver area, cm.²	Total precipitation, Apr. to Dec., 1922
Rain	1,000 with shield	295.9	1,000 with shield	175.2
	200 without shield	289.2	200 with shield	175.3
	Difference (per cent)	−2.3	Difference (per cent)	0.0
Snow	1,000 with shield	174.2	1,000 with shield	82.4
	200 without shield	153.7	200 with shield	86.1
	Difference (per cent)	−12.1	Difference (per cent)	+4.5

From the comparative measurements, as above set forth, it may be concluded:

1. That the accuracy of measurement of the amount of precipitation with the smaller gage of 200 cm.² receiver area is equal to, or perhaps a little greater than, that of the old Swedish gage of 1,000 cm.² area.

2. That the smaller gage of 200 cm.² receiver area is well adapted to snow measurement.

The continuance of comparative observations, especially in Abisko, so far as regards measurements at a single station, a demonstration under extreme conditions to follow would serve still further to clarify the question.

At the request of the editor Mr. S. P. Fergusson, of the Instrument Division of the Weather Bureau, has supplied the following references to the literature on the development of the rain-gage:

There is a considerable literature on the subject of gages of different sizes, etc., and apparently the most complete investigations relating to this subject are:

(1) The comparisons of rain-gages of different dimensions and kinds at different heights, at Rotherham England, 1865–1900 and probably later. Results have been published at various times in British Rainfall, 1865, to date, particularly 1869, and in the Symons Meteorological Magazine. Summaries have been published by R. E. Horton, in "*The Measurement of Rainfall and Snow*," in Jour. N. E. Water Works Ass'n, Vol. XXXIII, No. 1.

The gages employed varied in diameter from 25 to about 2,000 mm., the latter having an area of 0.001 acre.

(2) The investigations of Hellmann and others, mentioned in Lindholm's paper.

(3) Symons, G. J., "A contribution to the History of Rain Gages," in Quar. Jour. Roy. Met. Soc., 1891, probably contains numerous references up to that year.

All investigations apparently indicate that there is no appreciable difference in the "catch" of gages varying

in diameter from 25 to 2,000 mm. the ratio of areas being 1 to 6,000.

It seems very probable that differences found by some observers are due to differences of construction. My own experience in New England and in the West with different kinds of gages, indicates that gages with shallow funnels have larger and more variable errors than do the deeper gages. The greater splashing of the larger drops occurring in summer may explain the deficiency in catch of the 200 cm.[2] gage used by Lindholm at this time of year. In mild climates such as that of England, wet snow adhering to the funnel would cause a more variable, and usually a smaller, catch on the part of the smaller gage.

The ratio V (p. 262) is that of the cylindrical portion of the gage to the area of the funnel (or bottom of the receiver).

PRESENT METHODS OF GLACIER STUDY IN THE SWISS ALPS

J. E. CHURCH, JR.

[Mount Rose Observatory, Reno, Nev., July 10, 1923

Contemporaneous with the later studies in glacier phenomena by Prof. P. Mercanton, of the University of Lausanne, an abstract of whose work appeared in Scientific American Supplement 85:194–5 (Mar. 30, 1918), is the investigation being conducted under the auspices of the Glacier Commission of the Physical Society of Zurich by Prof. A. de Quervain, of the Swiss Central Meteorological Office, assisted by Dr. A. Billwiller. Current reports are published in the Annalen der schweizerischen, meteorologischen Zentralanstalt and in briefer form in the Jahrbuch Ski.

In addition to the traditional measurements of glacier flow, the commission is endeavoring to determine the relation of the source of supply to the forward thrust and retraction of glaciers and to obtain so far as possible a view into the evolution of the glacier snow beneath the surface. The Clariden and Silvretta Glaciers were selected as the subject of study.

As a preliminary, snow stakes were erected at the mountain huts in the catch basin of the individual glaciers to determine the current growth and dimunition in the snow cover, and seasonal snow gages, known as Mougin Totalisators, were installed to determine the total annual precipitation. These consisted of an orifice flanked by a Nipher screen and terminating in a reservoir containing a saline solution in which the falling snow is melted and conserved. A laboratory test of the resulting dilution determines the amount of gathered precipiation. And iron tripod raises the totalizator above the reach of drifting snow.

Although the totalizator is the last word in simplicity, it probably lacks necessary precision, for the air currents in the exposed situations in which the gages are of necessity placed, must often be too strong to be controlled by the screen, and, furthermore, the cold may at times congeal the surface of the liquid content and seriously reduce the capacity of the reservoir by depriving it of its power to change the snow into water. Finally, frost plumes will readily form in cloudy weather upon the orifice and until slowly melted by the returning sun will prevent the entrance of snow. On the other hand, the contents may even be abnormally augmented by "snow smoke" from neighboring peaks unless the totalizator is so situated as to be beyond such influence.

The uncertainty that exists regarding the accuracy of the snowfall measurements is heightened by the fact that glaciers are situated in depressions, well called glacial collectors, and are thus the natural recipients of the drifting snow, providing they lie in the lee of the wind. Some glaciers, also, may be abnormal losers of snow, if they face the sun. Consequently, with similar snowfall but dissimilar exposure to the wind and sun, two adjoining glaciers may act quite differently. Furthermore, some basins, as Mercanton has pointed out, may by their topography so restrain glacial flow that excessive accumulation is necessary before forward thrust can occur.[1] Therefore, to determine the factor of accumulation, measurements were begun of the seasonal residue of snow upon the glaciers themselves.

Two points were selected, one at either end of the glacier, and were marked by a steel tube, known as a buoy, which was usually extended 5 to 6 meters each summer to rise above the new snow of the following winter. At first, the accumulation about these buoys was measured in terms of height, a method of considerable accuracy at any time in the season where the snow is wind-blown but particularly so at the close of the season of melting when the snow has attained practically its highest density through crystallization, as shown by the extremes of 49.0 to 61.5 per cent relative density obtained during the first 3 years.

However, to obtain dependable accuracy in connection with buoy measurements and also to obtain a view beneath the surface, a Mount Rose Sampler, made in short sections to facilitate packing up the mountain, was imported into Switzerland just as the Great War was breaking, and by the development of a special ice cutter[2] has been used to penetrate through two seasons' accumulation to the total depth of 5½ meters. To mark the division between the seasonal layers, a sheet of ochre of red or yellow to facilitate identification is spread around each buoy. The tendency of the ochre stain to spread does not militate against its use, for the movement is downward with the percolating water. Consequently, despite a maximum penetration by the ochre of 165 cm., the line between the two seasons' snows is sharply defined.

The immediate result of the measurements was the demonstration that the winter snowfall upon the glacier surface suffers considerably during the brief summer season, for although the water content of the season's snow cover at the end of the major snowfall as on June 17, 1917, was within the reasonable correlation of 20 to 25 per cent of the annual catch in the totalizator, the water content on August 8 was almost 100 per cent divergent. Consquently, the total annual precipitation bears far less relation to glacier growth than the actual residue of snow that remains as the composite result of winter snows and summer melting; although it is quite possible that a portion of the percolating waters may combine with the glacial snows below.

The second result, brought to light by the divergence between the accumulation indicated by the buoy and

[1] The analysis of these three factors of accumulation, dissipation, and topography would find a harvest time of opportunity in a season such as 1918–19. In this year of heavy snowfall, as noted by Mercanton, of 100 glaciers, 69 were growing, 4 were stationary, and 27 were diminishing. It will be of great interest to obtain the statistics for 1920–21, when the snowfall was light and the succeeding summer unusually warm. Of course, large glaciers, or rather glaciers with large collectors, should show less seasonal variation and might even continue to grow over one or even more deficient seasons. As Professor Mercanton remarks in this connection, "the large snow glaciers have without exception manifested a tendency to grow."

[2] Owing to the tendency of the ice to melt under pressure and friction of the cutter and then to refreeze immediately above it, leaving it imprisoned like a fish in ice, a set of teeth was cut on its bulbous upper side in order that by reversing the direction of rotation of the sampler, the cutter could recut its way to the surface.

that actually measured by the sampler, was the discovery that the lower strata, at least to a limited distance beneath the surface, are undergoing diminution in depth, and the penetration of two seasons' layers in 1917 proved that this diminution was due to loss of water content through melting with but little increase in relative density and, consequently, with little change in crystallization. The loss reached 75 cm. water content in a total of 200 cm., a considerable amount in relation to the seasonal residue, but slight unless frequently repeated, if compared with the cross-section of the glacier. If this melting occurred beneath a new layer of snow, which was 330 cm. thick, the phenomenon has great significance, for it indicates hidden losses occuring in the depth of the glacier. However, it is probable that this melting occurred immediately after the original measurement was made, for August 16 seems too early a date for continuous freezing. At least, in 1917 a loss of 59 cm. or more occurred in the 1916–17 stratum after the August measurement was made. It is, possible, however, that percolating waters from the surface stratum directly above cause this melting as they filter through the fissures below, a normal procedure in snows where the temperature does not remain continuously below 32° F. Only late measurement after the season of melting is over will eliminate the uncertainty regarding the actual water content of a season's residual snow. When once the winter has set in, it seems highly probable that the residual snow of the preceding season is protected against further loss unless its surface is nearly or quite exposed.

Early autumn snows are no obstacle to late measurements, for they can be easily identified by their crystallization and eliminated. The preferred method is to make an early survey before any melting of the winter snow cover has occurred and a late survey, as apparently is now being done, after the melting has ceased. Thus the actual seasonal catch of snow by the glacier can be compared with the catch in the totalisator and both catch and summer's residue accurately determined. Only in this way can the three studies of the Zurich Glacier Commission, viz, precipitation, stream-flow, and glacier science be advanced.

Regarding the internal growth of glaciers, it is probable that the residual snow stratum of any season undergoes slow pressure by succeeding strata, until it finally attains the density and crystallization of glacial ice. Such process must naturally be slow, for the density before the heavier pressure begins has usually already reached the high percentage of 60 to 62.5, or 10 per cent higher than normally found in the Sierra Nevada. Indeed, on the Rhone Glacier in August, 1918, three strata of snow of a combined depth of 317 cm. were penetrated that showed the progressive density of 52.4, 59.0, and 74.3 per cent, respectively, but unfortunately through inability to find the ochre stains it is uncertain whether these three strata represent one or more seasons' snows. However, since the next stratum could not be penetrated despite several efforts to do so, it is safer to consider the three strata as belonging to one season. To settle the question of glacial growth, the annual measurements should be made late in the autumn and the development of the crystallization in the strata downward observed. This might be accomplished by pits or by shallow drifts into the wall of a crevasse, if the latter operation is at all feasible. However, since a gap of only 17.4 per cent still remains between the 74.3 per cent found near the surface of the Rhone Glacier and 91.7 per cent, the density of solid ice, the evolution of solidified snow to coarse glacial ice should be a matter of a few meters depth or a slight increase in pressure, if indeed, temperature itself does not effect the complete evolution unaided by pressure.

The determination of the details of the phenomenon of rapid thrust and retraction must await the accumulation of several years of measurements—of years abnormally heavy and those abnormally light, and each type should preferably be bunched. Furthermore, the heavy winters should be followed by cold summers and the light winters by warm summers to accentuate the extremes.

Fortunately, precipitation is usually uniform within 10 to 20 per cent for distances of 100 to 200 miles along a mountain range, as shown by snow surveys and studies of stream flow in the Sierra Nevada. Consequently, one precipitation station or snow survey course, if carefully located beyond possibility of being affected by wind, will serve a considerable area. However, the tendency of each glacial basin to be affected by wind and sun must be determined in the case of each in order to apply the seasonal percentage of precipitation correctly. Basins acting out of unison with their neighbors should be studied individually.

Although glacial ice responds more slowly than water to pressure, there seems to be no reason to expect any fundamental difference from the general law of hydrostatics. Increased head should result in increased rate of flow and vice versa and the terminus of the glacial tongue should be determined by the component of glacial accretion and disintegration. In other words, it should depend upon the interplay of precipitation and temperature, modified, of course, by the plasticity of the glacial ice.

The tendency of glaciers to flow "by fits and starts," or, changing the figure, to explode through excessive tension, seems to be a question of attaining momentum, while the tendency of the "intumescence" to advance more rapidly than the glacier itself could well be the counterpart of streams in flood, whose main current is paralleled by reverse currents near the shore.

Increase in velocity with increase in temperature, though reaching 100 per cent as between the widely divergent temperature of winter and summer, is relatively small as between the normal and supernormal temperature of either, and is a distinctly minor phenomenon as compared with velocity due to pressure. For example, the Mer de Glace in Switzerland moves about one-half foot per day in the center in winter and one foot per day in the summer whereas the glaciers in Greenland flowing from the deep ice cap "usually move about 20 feet per day, and may progress as fast as 50 to 60 feet daily." [3] Yet the mean annual temperature of Switzerland in 35° F. higher than in Greenland.[4]

For those who seek correlations, the appended table on Klariden Glacier will prove of interest. It indicates the general plan and pathetic paucity of assembled data. However, resolute hearts and sturdy bodies will gradually fill the gaps in glacial knowledge. Even as early as 1920, the auspicious beginning caused Doctor Billwiller to remark: "Our glacier commission is growing in years; marked not by the number of our annual reports, nor the pains it has cost nor the sweat, and the weight of the pack, but by the satisfaction with which our insight into the mutual working of glacier growth and melting is deepening year by year."

[3] Excerpted from Rapports au Conseil Federal Suisse by Nigretti & Zambra in Meteorological and other Facts and Data, 1920.

[4] Mean annual temperature of Switzerland approx. 50-55° F.; of Upernavik, Greenland approx. 15-20° F. (Buchan, Atlas of Meteorology).

TABLE 1.—*Glacier studies on Klariden Glacier, Switzerland*

Period	Seasonal snowfall: Totalisator (Geissbutzistock), cm. water annual, Aug. to Aug.	Seasonal snowfall: Upper buoy (maximum snow depth in May) cm. snow	Character of year: Winter and spring	Character of year: Summer	Seasonal residue of snow or glacier growth (sampler measure Aug. or Sept.), cm. water: Upper buoy 2,900 m. elevation	Seasonal residue of snow or glacier growth (sampler measure Aug. or Sept.), cm. water: Lower buoy 2,708 m. elevation	Rise or fall of Niveau (m.)	Flow of glacier as measured at buoys (m.)
1914–15 (Nov.–Aug.)						125 [1]		
1915–16 (Aug.–Aug.)	401				Approximately 258 [2].	Approximately 192 [4].		
1916–17 (Aug.–Aug.)	344	430	Heavy precipitation.	Warm	Approximately 222 [3].	0	Sunk	
1917–18 (Aug.–Sept.)	363	550 or more	Maximum snow depth in July.	Fair weather	238	120	Somewhat risen.	Upper buoy 18 m. (1 yr.) Lower buoy 11.9 m. (2 yrs.)
1918–19 (Sept.–Sept.)	380	550 or more (at Hut 380 in May).	Abnormally heavy snowfall.	Warm Aug.–Sept.	338 or more	242		East end 29 m. (1 yr.)
1919–20 (Sept.–Sept.)	380				336 [5]	84		Buoy covered by new snow in August before measurement could be made.
1920–21 (Sept.–Sept.)	210	205 (Mar. 31) 265 (July	Abnormally light snowfall.	Abnormally warm.	0 (Aug. 3) [6] −39 (Sept. 15)	350 (Aug. 3) [6] 500 (Sept. 15)		Buoy buried in 1920 reappeared. By it movement 2 years (1919–21) 32 m. S. E. By new buoy 1 year (1920–21) 13 m. S. E.

[1] Estimated on basis of 60 per cent of depth of 209 cm.
[2] Estimated on basis of 60 per cent of depth of 430 cm.
[3] Estimated on basis of 60 per cent of depth of 370 cm.
[4] Estimated on basis of 60 per cent of depth of 320 cm.
[5] Buoy lost. Estimated on basis of 60 per cent of depth of 209 cm.
[6] Season's snow entirely melted, so sampler could not be used. Losses of previous season's residue indicated by minus quantities, is on basis of 60 per cent of depth measured, though on account of pressure and weathering, it may be somewhat more.

WIND DIRECTIONS AND VELOCITIES, NASHVILLE, TENN.

By ROSCOE NUNN, Meteorologist

[Weather Bureau, Nashville, Tenn., June 5, 1924]

WIND DIRECTIONS

The writer has often wondered as to what may be usually understood by the expression, "prevailing wind direction." It is perfectly clear to the meteorologists, but probably not at all so to the technically uniformed. The ordinary statement, "prevailing wind," means the wind that was registered or observed most often during a given period—the one direction, of the eight principal points of the compass, from which the wind was most often blowing.

If the prevailing wind for any month should be published as "north," that would mean that no other direction, of the eight points considered, was registered as often as north; but it would not mean that the wind was from the north most of the time, nor necessarily for even any high percentage of the time. It is conceivable that the wind might blow from each direction the same length of time during a day or a month; then each of the eight directions would have a percentage of 12.5; but if north should have 13 per cent and no other direction more than 12.5, then north would be the "prevailing wind," although, as a matter of fact, the other seven directions might be practically as highly represented as north.

As usually published, "prevailing wind" data are inexplicit. In order really to understand the characteristics of the wind at any station, the percentages of time for each direction should be known. To furnish such information is the object of the first part of this paper,

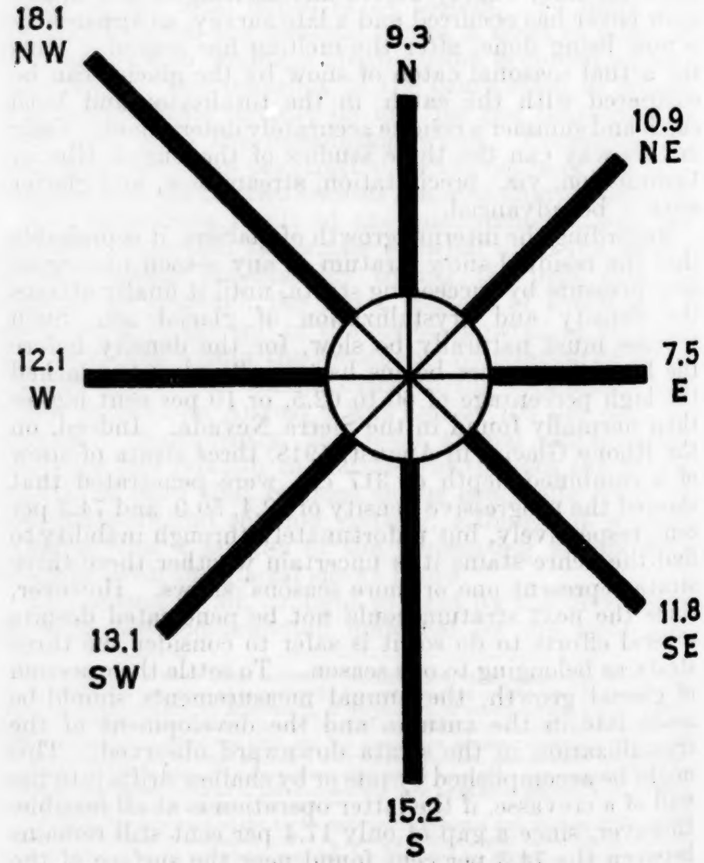

FIG. 1.—Annual average percentage of time the wind blows from the eight principal points of the compass at Nashville, Tenn.

while in the second part is given some data not ordinarily available in regard to wind velocities.

There seems to have been but little detailed wind direction data published. In the Weather Bureau Bulletin Q, Climatology of the United States, by Prof. Alfred J. Henry, pages 68–70, are given tables for 20 stations in the United States, showing the monthly and annual percentages of winds from each of the eight principal points of the compass for the 10-year period 1894–1903. Tennessee and adjacent States are not represented directly, Cincinnati, St. Louis, New Orleans, and Savannah being the nearest surrounding stations for which data are published. It seemed, therefore, of interest to compile records (Table 1) for Nashville, where the exposure of wind instruments has been good during the greater portion of the records and especially for the years selected, viz., 1895–1904 and 1918–1924. The two periods were combined and averages in the table are for 16 to 17 years, a period long enough to give fairly stable means. The figure showing the annual relative prevalence of the different winds is based upon records for the same combined periods.

TABLE 1.—*Wind, average percentage of time from each direction, Nashville, Tenn.*[1]

	N.	NE.	E.	SE.	S.	SW	W.	NW.	Calm	Prevailing direction
January	8.6	9.1	8.5	10.9	16.2	12.2	12.2	20.6	1.1	NW.
February	10.8	9.6	6.8	9.6	14.8	11.8	10.6	25.2	0.6	NW.
March	10.1	10.6	7.5	13.2	20.5	9.9	8.8	18.4	0.8	S.
April	9.2	10.3	7.5	12.0	19.9	10.7	10.5	17.6	1.6	S.
May	9.1	11.4	9.2	11.6	14.8	14.9	11.0	15.6	2.5	NW.
June	9.0	11.4	6.7	10.4	11.0	16.8	15.8	16.4	2.5	SW.
July	8.1	10.1	6.5	10.5	12.4	19.2	16.2	15.8	1.0	SW.
August	8.6	11.1	7.1	11.2	12.2	16.8	15.5	15.8	2.2	SW.
September	10.5	13.1	9.6	11.9	12.7	10.9	9.6	17.9	3.8	NW.
October	8.9	13.7	7.2	14.1	14.4	10.0	10.2	17.8	4.1	NW.
November	10.0	11.2	6.5	14.2	16.4	9.6	12.2	18.6	2.4	NW.
December	8.4	9.2	7.1	12.3	17.6	13.9	12.7	17.5	1.3	S.
Year	9.3	10.9	7.5	11.8	15.2	13.1	12.1	18.1	2.0	NW.

[1] Compiled from records of self-registering instruments, period of 16–17 years (1895–1904, inclusive, and January, 1918, to April, 1924, inclusive).

WIND VELOCITIES

Some years ago investigation was made to determine the character of the wind movement at Nashville as shown in relative frequency of various velocities, or percentages of time the wind blows at stated velocities. The information was not published at the time. The results are now shown in Table 2.

It is necessary, of course, to consider the elevation of the instrument above ground and the other conditions of exposure in the use of all anemometer records. The exposure of the anemometer at Nashville has varied from a rather low elevation above ground during the early years to high during the last 15 years, During the period 1895–1904, which was used in the compilation of Table 2, the anemometer exposure was unchanged and the instrument was 134 feet above ground, with no high buildings near. This was a very good exposure at what might be called a medium height above ground. Following this period, the instruments were exposed on the roof of the Custom House annex for about five years, under unsatisfactory conditions, and in March, 1909, they were removed to the present location, where the anemometer is 191 feet above ground and where the wind movement registered is decidedly greater than at any previous location. No doubt the anemometer exposure of 1895–1904, height above ground being 134 feet, gives data more nearly representative of the wind movement as it affects buildings, trees, etc., than the present high exposure.

TABLE 2.—*Wind, percentage of time at stated velocities, Nashville, Tenn.*[1]

	Velocities, miles per hour:							
	0–5	6–10	11–15	16–20	21–25	26–30	31–40	41–50
January	40.8	34.0	16.0	6.2	2.0	0.7	0.1	0
February	33.8	39.2	18.8	6.7	1.5	0.2	0.2	0
March	29.8	36.3	21.1	9.0	2.8	0.8	0.1	0
April	33.3	38.1	19.6	6.5	1.9	0.5	0.1	0
May	48.4	36.1	12.4	2.7	0.1	0	0	0
June	53.8	35.5	8.6	1.4	0.2	0	0	0
July	57.3	34.9	7.5	0.5	0	0	0	0
August	64.0	30.6	4.9	0.1	0.2	0	0	0
September	57.8	31.5	9.4	1.0	0	0	0	0
October	57.5	29.3	9.8	2.7	0.5	0	0	0
November	48.4	30.7	15.4	4.5	0.7	0.1	0.1	0
December	40.5	36.7	16.5	4.6	1.1	0.7	0.1	0
Year	47.1	34.4	13.3	3.8	0.9	0.25	0.06	0

[1] From records of 10 years, 1895–1904, inclusive. Elevation of anemometer above ground, 134 feet; above sea level, 594 feet

In connection with both wind direction and wind movement, Table 3 is presented to show the average velocity of the wind from the eight principal points. This information was easily compiled from the data found on page 13, Form 1001, which was begun January 1, 1918. The record is for a period of only 6 to 7 years; however, it gives averages that may be fairly substantial. These are the first data showing relative strength of the winds from different directions that this station has prepared, and I can not recall any previously published data of just this character for other places.

TABLE 3.—*Wind, average velocity for each direction, miles per hour, Nashville, Tenn.*[1]

Stations	Jan.	Feb.	Mar.	Apr	May	June	July	Aug.	Sept.
	N.	NE.	E.	SE.	S.	SW.	W.	NW.	Mean
January	9.4	8.5	6.2	7.9	10.8	10.1	9.8	12.2	9.4
February	10.4	8.8	6.2	9.1	10.5	11.1	9.4	12.4	9.7
March	10.5	8.2	6.9	11.5	14.3	13.8	12.2	13.8	11.4
April	10.3	8.8	7.2	11.1	12.7	11.5	10.6	12.2	10.6
May	8.1	7.7	6.2	8.0	9.4	9.1	7.1	9.0	8.1
June	7.8	7.7	6.0	6.4	7.4	7.8	6.9	7.6	7.2
July	7.0	6.7	5.8	6.1	6.7	7.0	6.4	6.6	6.5
August	6.8	6.5	5.6	6.2	6.6	7.3	6.0	6.8	6.5
September	6.7	7.5	5.6	6.5	6.8	7.6	5.5	6.8	6.6
October	7.9	6.7	6.0	9.6	8.6	7.8	6.4	10.0	7.9
November	9.0	7.5	5.8	10.4	11.1	7.4	8.1	11.1	8.8
December	8.2	7.6	5.8	10.4	12.8	10.8	11.0	13.3	10.0
Year	8.5	7.7	6.1	8.6	9.8	9.3	8.3	10.2	8.6

[1] Compiled from records for the period January 1, 1918, to April 30, 1924 (6–7 years). Height of anemometer above ground, 191 feet; above sea level, 675 feet.

PHYSIOLOGICAL HEAT REGULATION AND THE PROBLEM OF HUMIDITY

By Prof. E. P. LYON, M. D., Dean of the Medical School, University of Minnesota

[Excerpts from paper read at the January, 1921, meeting of the American Society of Heating and Ventilating Engineers at Philadelphia, and published in part in The Heating and Ventilating Magazine, New York, Feb. 1921, pp. 43–45]

This paper discusses the heat regulation of the human body as an engineering problem and brings out the importance of humidity as external aids to this process.

The human body is a thermostat, the temperature of the body—that is, the internal parts—is constant. By constant is meant exactly what engineers mean when they say the temperature of a room with thermostatic control is constant. It really varies somewhat, and the small variations are made the basis of regulation.

The body is a machine for transforming energy. One aspect of this transformation is the developing and regulating of heat. The constant temperature of the body is an expression of the fact that the body loses heat as fast as it produces it, or produces heat as fast as it loses it.

* * * One gram of starch or fat will give in the body exactly as many calories as if burned in a bomb calorimeter, and the waste products are the same.

The more important element of body temperature regulation is, however, on the heat-loss side. The body loses heat in several ways. Usually it is warmer than the substances (air, especially) in contact with it. Therefore, according to the laws of physics, heat will be conducted as heat into neighboring matter. The rate of such transmission varies with the difference in temperature of the substances in contact; say, body surface and air. This difference in temperature may vary from the outside in a variety of ways. By use of a fan we can renew the layer of air frequently and thus increase temperature difference and heat loss. By clothing we can keep the layer of air in contact, raise its temperature, and diminish the rate of heat loss by conduction.

The rate of heat loss by conduction also depends on the heat capacity and conductivity of the material in contact with the skin. Moist air has a greater heat capacity than dry air of the same temperature. Hence at temperatures around the freezing point and somewhat above moist air "feels" colder than dry air of the same temperature. The moist air takes away heat from the skin faster; therefore, the skin is cooler. Conditions are very different at higher temperatures, where atmospheric humidity, by hindering evaporation, is a heat preserving factor for the body. Thus arises the anomaly that humidity may keep us warm or cool, depending upon the temperature of the air in which the moisture is held. * * *

The third way in which the body loses heat is by evaporating water. This occurs at both the skin surface and the lung surface. The rate of evaporation and consequently of heat loss varies with numerous factors. It increases with temperature of the air on the skin, and therefore acts, in general, opposite to conduction and radiation, which is a fortunate fact. Evaporation increases with increased renewal of air, consequently a fan or wind cools the body; as likewise does rapid breathing, except in so far as it increases the rate of oxidation. Evaporation rises with increase of the surface of liquid exposed. We expose more liquid surface when we sweat than when the skin is, as we say, "dry." Of course it is never absolutely dry, and insensible perspiration is constantly being evaporated.

By the three methods mentioned, namely, conduction, radiation, and evaporation of water, the body loses practically all the heat that it produces. All of these vary in rate with external and internal conditions. All of them become ineffective under conditions of combined high temperature and high humidity.

Various external factors have been referred to, that affect the rate of heat loss by the three methods of conduction, radiation, and evaporation. The body from its side is not passive. It has two ways of accomodating or adjusting itself to the three methods of heat loss and thus keeping a constant temperature. The first is by distribution of the blood. When the outside temperature is hot, much blood is sent from the internal parts to the skin. The skin temperature is raised by this warm blood and the rate of heat loss by conduction and radiation is increased. When the outside temperature is low, little blood is sent to the skin and less heat is lost by conduction and radiation.

The second method of internal adjustment is the sweat secretion. This liquid, which is practically nothing but water, is extracted from the blood by coiled tubes, called sweat glands, located in the skin. When the temperature is high the amount of secretion increases; the liquid surface to the air increases; evaporation increases; the heat loss increases; and the temperature of the body falls. * * *

Man adjusts himself to every degree of atmospheric moisture from the practically absolute dryness of subzero air to the saturated air of tropical forests. Humidity is of little importance except when considered in connection with other conditions, particularly temperature and air movement.

I advocate strongly the artificial humidification of dwelling houses in winter in our northern States. The standard should be as high as can be secured without precipitation on inside walls. I do not think we can go above 50 per cent in our houses, as ordinarily built, even with double windows.

On account of leakage the amount of water to be evaporated is large; say 15 or 20 gallons a day for a small house. Therefore, the devices on the market, to be used on radiators, are all absolutely inefficient. Tests show that few of them evaporate as much water as one person gives off from his lungs. Most of the devices used in connection with hot-air furnaces are of little real use.

The problem can be solved, but it requires special attention to certain factors of evaporation, namely, surface of contact of water and air and movement of air. These are more important under house conditions than temperature. * * *

As a matter of opinion I may say that some type of humidifier by which air movement would be created, e. g., a combination of electric fan and convenient water surfaces, would be the ideal. Why should not people be willing to pay for humidity and air movement, two important hygienic factors?[1]

The most usual condition under which the body-heat control breaks down is high humidity and high temperature combined. This condition obtains in crowded rooms and auditoriums, because every person gives off both heat and water vapor. Such rooms need, primarily, new and moderately heated air. Movement of air also helps. Movement under extreme conditions, for example, saturated air of body temperature, would not help heat loss at all, but under usual conditons and for reasons already given it does help.

Movement of air in our public places and homes should be worked for. If we become accustomed to air in motion, we are less affected by outside conditions, where such movement is the rule. We ought to be accustomed to drafts and not affected by them. I shall not be surprised if we come to use electric fans in winter, even more than in summer.

The greatest problem from the standpoint of humidity is the home or office, where a few live and work, in winter in our northern States. We take into our house subzero air which has almost no water content and heat it to 70° F. Even with the water which such air eagerly laps up from furniture, plants, cooking processes, and from the skin and lungs of every occupant, nevertheless this air in our homes is likely to be drier than that of any desert on earth.

[1] Some of this expense would be off set by the saving in fuel because properly humidified air does not need to be at such high temperatures for comfort.—EDITOR.

The body thermostat can adjust the temperature of the internal organs to these conditions. There is not such discomfort and danger as comes from overcrowded, unventilated movie theaters or school-rooms. But there are somewhat important disadvantages.

In the first place, in order to keep up the body temperature in dry air, much blood is withdrawn from the skin. Moreover evaporation is active. The skin is cooled, and we "feel chilly." Hence the tendency is to have hotter rooms, up to 75° to 80°, and even 85° F. The skin gets cracked and rough, which is not pleasant to say the least. The same tendency to rapid drying extends to the mucous surfaces of the nasal passages, the pharynx and trachea, with consequent respiratory disturbances. Nose and throat specialists, generally, attribute the frequency of infections in winter more to the dryness than to the cold. This amounts to saying that in order to protect its indispensable internal temperature, the body has to abandon more or less the outlying provinces such as the skin and mucous surfaces. They have not enough blood and get dry; they pick up germs and become inflamed. * * *

THE UNSEASONABLE WEATHER OF MAY, 1924

By ALFRED J. HENRY

It was the privilege of the writer to contribute to this REVIEW some account of the cold spring of 1907.[1]

The present spring resembles in several, though not all respects, that of 1907, and since it affords an opportunity to attempt to correlate the weather in the United States with that of other portions of the Northern Hemisphere some space will be given to that end.

May is a month when normally in the Northern Hemisphere temperature should rise; it is well known, however, that the temperature in that month in some years, but not in all, suffers interruptions of greater or less duration and intensity, thus the temperature instead of rising sinks materially and sometimes continues at a low point for a week or 10 days. When these interruptions are more or less continuous over a considerable time the result is a cold and backward month such as occurred in north-central and northeastern United States in May, 1882, in practically the whole country in 1907 and 1917, and in a less degree in the month here under discussion. This phenomenon has been recognized for more than 100 years and in the meantime a very considerable literature thereon has been developed.[2]

In the last 40 odd years May was exceptionally cool east of the Rocky Mountains in 1882, 1883, 1888, 1890, 1907, 1917, and 1924.

Cool weather in May is due to several causes operating singly or in conjunction. The first and chief cause apparently has its origin in the polar regions and is manifest in temperate latitudes of both hemispheres by an unusual flow of cold polar air toward the equator; as a direct result of such flow masses of cold and warm air, respectively, are brought into contact, vertical and horizontal convection produces condensation and much cloud and rain. Insolation is, therefore, hindered and thus contributes to a lowering of the temperature, or shall we say prevents the normal increase in temperature due to the incoming solar energy. May, 1924, in northeastern United States was exceptionally cloudy and rainy. While the rainfall here in Washington was not exceptionally heavy, it was nearly continuous after the 12th. From that date until the close of the month the greatest interval of fair weather did not exceed two days.

THE WEATHER OF PREVIOUS COOL MAYS

May, 1882.—In the United States this month was characterized by low temperature, the lowest in 40 years or more in northeastern districts; heavy rains in the Ohio Valley; much ice in the region of Newfoundland, also on the coast of Nova Scotia, the harbor at Halifax being ice-bound in the last decade of the month. Outside of the United States the only observational data available are those contained in the Signal Service International Bulletin. That publication contains monthly means of pressure, temperature, and wind direction for one station each in the Faroes, Iceland, and Greenland. From these data it is established that pressure in the Arctic was above normal with polar winds (from the pole); the Icelandic minimum was centered to the southwest of that island, approximately in north latitude 55°, West longitude 20°. The Azores maximum was likewise to the southwest of its usual position. In the British Isles both pressure and temperature were above normal, the former by 0.04 inch and the latter by 3. Temperature was less than normal in the Azores and quite generally throughout Iceland, Norway, Spain, Italy, and Portugal and points in the Black Sea region.

The paths of anticyclones in the United States show clearly the movement of masses of cold air over the Canadian Maritime provinces and fully explain the pressure abnormality of plus 0.30 inch at St. Johns, N. F. The origin of these disturbances was apparently north of the Great Lakes, especially in the region of Hudson Bay.

May, 1907.—The observational data for this month, although greater than for 1882, are lacking almost entirely for northern Canada and Alaska.

The writer in discussing the cold spring of that year[3] attributes the unseasonable weather to the pressure distribution over the North American Continent in consequence of which the intrusion of masses of cold air by way of the upper Missouri Valley were greatly facilitated.

In Northwestern Europe after the middle of the month there was a greater or less influx of cold polar air, as witness the following excerpt from Weekly Weather Report, London 1907, p. 164.

"High pressure in Iceland and off the west coast of Europe and low pressure over central Scandanavia established a gradient for northerly winds over the British Isles and indeed from the Arctic to the Mediterranean. Low temperature for the season prevailed generally over Europe practically to the close of the month."

No information relative to the ice about Newfoundland is available but the pressure at St. Johns N. F. was 0.14 inch below the normal, directly the opposite of that for May, 1882, when, as before stated there was much ice at that place.

May, 1917.—An account of the cold weather of this month will be found in this REVIEW for June 1917.[4] The exceptional character of the weather of that month was the low temperatures that prevailed in *all parts of the country*, the absence of extremely low minima, the lack of sunshine and consequently the failure of the day temperatures to reach the usual high values.

[1] Henry, A. J. The cold spring of 1907, Mo. WEATHER REV. 35: 223-25.
[2] Cf. this REVIEW 47: 555-65.
[3] Loc. cit.
[4] Day P. C The cold spring of 1917; 45: 285-89.

May, 1924.—For this month definite information is not yet at hand respecting the pressure distribution at points outside of the United States and Canada but thanks to a timely articles in the Meteorological Magazine by Mr. C. E. P. Brooks[5] general information respecting the pressure and temperature distribution for the early part of the year is available.

We summarize from the article as follows:

The winter of 1923–24 inthe British Isles was characterized, particularly in November and December, 1923, and February and March, 1924, by an abnormal frequency of northerly and easterly winds.

Charts of monthly pressure deviation which are now regularly drawn for western Europe, the North Atlantic, and North America show that pressure as far back as October, 1923, was much below the normal north of Scotland—15 mb., the deficit increasing to 18 mb. over the Faroes. In North America an excess of 5 mb. was noted in the Missouri Valley. In November, 1923, the pressure deficit, now but 10 mb., was found over the Baltic.

Pressure over the North Atlantic was above normal, the excess being 5.6 mb. at Horta and 11.5 mb. at 50° N. 30° W., over the British Isles the lines of equal pressure departure were directed from north to south and northerly winds were abnormally frequent. In December the conditions were somewhat similar but the area of pressure deficit had shifted northward and the pressure-excess was now centered between Azores and Corunna. Pressure distribution over the North American Continent in December was without special significance. After two consecutive months of above-normal pressure, a reaction to lower pressure took place east of the Rocky Mountains.

During January, 1924, pressure was 5 mb. below normal over the ocean between Iceland and Scotland; in North America pressure was generally in excess of normal, the greatest excess being 6.8 mb. over the Great Basin. During February pressure over the North Atlantic west and northwest of the British Isles was above normal by about 10 mb. In North America pressure was again in excess except along the Atlantic coast north of Florida.

During March, 1924, pressure was below normal over the North Atlantic southwest of the British Isles, the greatest deficit being 15.5 mb. at Horta; it was 6.7 mb. above normal at Stykkisholm, Iceland, and since the average pressure difference between these two stations in March is but 12.5 mb., it follows that the normal pressure was completely reversed; hence, cold easterly winds prevailed over the British Isles.

Pressure for this month over North America, especially the Canadian Maritime provinces was exceptionally low, a deficit of 12.5 mb. being noted on the Nova Scotia coast. It may well be that pressure over the entire north Atlantic between certain latitudinal limits was well below normal. This is the most significant fact as regards the weather that has thus far been developed.

This great depression of the barometer over the Atlantic Ocean during March was associated with the eastward movement from the United States of a rather large number of cyclonic systems most of which passed to sea south of North latitude 40°. The movement thus initiated seems to have continued during April, although in a somewhat diminished degree. It seems clear that pressure over the middle-western north Atlantic, as indicated by the two stations, Horta and Bermuda was nearly normal during April and May; there was, however, an unbroken period of low pressure and cyclonic activity at St. Johns from May 14 to June 11, 1924.

In May, 1924, the movement of cyclonic systems across the United States was grouped along two paths—first across the Canadian Maritime Provinces from the region of the Great Lakes, and second from the Virginia capes northeastward toward the Grand Banks (see Chart II). Anticyclones, on the other hand, avoided the region east of the Mississippi as may be seen from Chart I.

In this connection mention should be made of a news item that appeared in the public prints, some days ago, to the effect that sea-water temperatures in the vicinity of the Grand Banks were about 7° F. higher than usual for the season.

The authority for the statement is Lieut. E. H. Smith, of the United States Coast Guard, in charge of meteorological work on the Intrnational Ice Patrol. It would be premature to discuss this fact in the absence of exact information as to what the observations on the Ice Patrol disclose.

The conclusion that this discussion seems to point to is that May temperatures in the United States, at least, are conditioned upon the vigor of the circulation of air between the equator and the poles. When the balance in the exchange is on the equatorial side temperature rises perhaps a little faster than when the exchange is normal, and when, on the other hand, the balance in the exchange is on the polar side, as in the cool Mays discussed, the normal seasonal rise in temperature is retarded both by direct importation of cold air and the formation of great cloud blankets induced thereby, which intercept solar radiation and produce a lowering of the temperature.

It is also evident that the phenomenon of cold Mays is a complex problem. The cold May of 1882 was a month rich in ice about Nova Scotia; the current month was exactly the opposite. Pressure over the Canadian Maritime Provinces in 1882 was high; in May, 1907, 1917, and 1924 it was low.

In the last-named year the low pressure in the western Atlantic was preceded by exceptionally low pressure in various parts of the eastern Atlantic for the six months preceding, the locus of the low pressure shifting about as hereinbefore indicated.

DESTRUCTION OF AN AERIAL DURING A THUNDERSTORM

By IRVING F. HAND

[Weather Bureau, Washington, June 30, 1924]

Since radio has become so popular it is thought that a short account of the destruction by an electric discharge of the aerial used by the Solar Radiation Investigations section of the Weather Bureau at the American University, during a severe thunderstorm on June 18, will be of interest.

The aerial was about 25 feet above ground at both ends, 70 feet long, insulated at one end by a porcelain cleat from the guy wire, which was attached to a tree about 15 feet distant. The other end of the aerial was fastened to a switch on a window sill of the observatory. This switch was open during the storm so that the aerial was an ungrounded unit. Both the aerial wire and the guy wire passed through a three-eighths-inch hole in the porcelain cleat, as it was thought that aside from serving as an insulator, the gap of about $\frac{1}{32}$ inch between the wires in the cleat would act as a lightning arrestor as soon as the tree became sufficiently wet to make a good ground.

[5] C. E. P Brooks, The abnormal weather of the winter and early spring, 1923–4; Meteorological Magazine, May, 1924.

The storm, which occurred during the afternoon of June 18 was apparently at its greatest intensity between the University and a point 1½ miles to the ENE.; lightning having struck at several points within this region. The rainfall recorded at the American University was 1.48 inch as compared with 0.59 inch at the Central Office of the Weather Bureau 3 miles to the southeast; 80 per cent of this fall taking place within a 20-minute period. An 80-foot flagpole 100 yards from the observatory was snapped off at about its midway point, or just above four large guy wires. There was no evidence of the pole having been struck.

In searching for the aerial wire after the storm, pieces of the insulation were found at various intervals which contained minute quantities of copper; in some of the samples examined, apparently 95 per cent or more of the copper had been blown out of the insulation, which latter consisted of two paraffined layers of cotton thread wound in opposite directions. Larger pieces were found, however, stripped of their outer layer of insulation, which, while retaining somewhat their original cylindrical shape, had a rough and pitted surface and contained a hollow bore, with evidence of fusion at many points. Careful search failed to reveal an unbroken piece of the aerial more than 3 inches in length, while these longer pieces are so altered and shattered that care must be exercised to preserve them in an unbroken state.

The hole in the insulator through which the aerial wire and the guy wire passed was heavily copper-coated, as was also a portion of the outer rim of the insulator. About 13 feet of the guy wire was missing; only a portion extending 2 feet from the tree and the section which was wound around the trunk of the tree remaining. This short piece of No. 18 office wire was unharmed, it appearing as though a mechanical break had occurred, rather than that disintegration had taken place up to this point.

Three possibilities as to the nature of the "stroke" which caused the damage to the aerial occur to the writer, as follows:

(1) *A direct hit.*—Direct hits may occur within wide limits of intensity. Inasmuch as the aerial ran from a well-grounded building 60 feet in height to a 40-foot tree, it is more than likely that the building and the tree were also "struck," providing the phenomenon were of this type.

(2) *A "bound" charge.*—If the aerial were in an electrostatic field, the current of the same polarity as that of the dielectric immediately surrounding the aerial would tend to leak off leaving an opposite charge on the aerial. This latter charge, as soon as the potential gradient between the cloud and the ground collapsed, would neutralize with its complementary charge; this action being accomplished by discharging a major portion of its current to the ground by way of the guy wire and the wet tree.

(3) *Induction.*—While this phenomenon occurs with every stroke, severe damage by this means is rather infrequent. No trace of a direct hit within a short distance has been found.

Clarence LeRoy Meisinger, 1895–1924

To the close of kin and the dear in affection, every death is a disaster. But to humanity the most valuable life, and the saddest to lose, is that of the young scientist just well started on an obviously brilliant career. It was this loss to all the world that evoked the many earnest tributes throughout America and in countries abroad to the memory of that enthusiastic and highly productive meteorologist, Clarence LeRoy Meisinger.

Doctor Meisinger was born at Plattsmouth, Nebr., April 30, 1895, and died in the line of duty—riding the tempest to learn its secrets—near Bement, Ill., June 2, 1924. He graduated from the University of Nebraska in 1917 with the degree of B. Sc., and subsequently obtained the degrees M. Sc. and Ph. D. at the George Washington University. He was an active member of the American Association for the Advancement of Science, the Philosophical Society of Washington, and the American Meteorological Society. In fact he attended every meeting of this latter society, and always had a good paper to present.

In June, 1921, he was happily married to a childhood playmate, the pretty and accomplished Helen B. Hilton, of Lincoln, Nebr.

During the World War he served with distinction in the Army, mainly in the Meteorological section of the Signal Corps, where he attained the rank of second lieutenant, and won his license as a free-balloon pilot. In this capacity he quickly realized that there were many things concerning the air and its ways that no one fully understood. He wanted especially to know what currents of air exist, and why they blow as they do, at ballooning levels. This was the problem, difficult in theory and formidable in magnitude, that he deliberately made his own, not ignorantly and without purpose, but after abundant counsel and with firm resolve to devote to it years of patient study and persistent labor. It soon appeared that flights in free balloons at constant levels should furnish much of the desired information. Hence, Doctor Meisinger's first investigational flight, begun on April 16, 1919, while he was still connected with the Army, was made in this manner. Shortly after this preliminary exploration, which was entirely successful, Doctor Meisinger entered the service of the Weather Bureau. Here he was associated with the editor of the MONTHLY WEATHER REVIEW, and at once became both an earnest student of meteorology and a frequent contributor to that science. His original papers in the MONTHLY WEATHER REVIEW, apart from notes, reviews, and comments, averaged nearly 5 a year, there being 18 in all. In addition to these he published, in 1922, as SUPPLEMENT 21, a most valuable contribution, full of promise alike to the aviator and to the forecaster of coming weather. This paper, "The Preparation and Significance of Free-Air Pressure Maps for the Central and Eastern United States," was the result of a very great amount of labor, guided throughout by well-considered original ideas, and though condensed to the minimum for accuracy and clearness, would alone make a volume of considerable size. He also published many semipopular papers in various journals; and, in addition to this, had begun the preparation of a book on aeronautical meteorology.

By using all available data, and devising rapid yet reliable reduction schemes, he had already brought into clear sight the construction of upper air weather charts with that amazing speed, and nearly the accuracy, with which the surface map is drawn. The value of such maps to the aviator is obvious, and besides, on many occasions they would be of great help to the forecaster.

It was to get information needed for the completion of certain portions of this study of the movements of the air in storm areas that he earnestly sought, and finally obtained, an opportunity to make a series of free-balloon flights under various weather conditions, and in the different sections of a general storm area. In addition to

these data of major value, he expected also to get many facts concerning the dust in the air at flying levels, haziness, size of cloud particles, and nature of any other atmospheric or storm phenomena that might come under his observation. Lieut. James T. Neeley, a skilled free-balloon pilot of the United States Army Air Service, and a former associate of Dr. Meisinger during the war, was his companion on these trips and perished with him.

The first of this series of flights started at Scott Field, as did all the others, near St. Louis, in the late afternoon of April 1, and terminated about the same time the next afternoon in South Carolina. In a letter to Prof. A. J. Henry of the Weather Bureau about this flight, he says:

> I couldn't have wanted a better weather type for a starter, because it gave excellent opportunity to try everything out and get accustomed to the routine. It was worth while in every way. We maintained our level at between 7,000 and 8,000 feet which is quite satisfactory when one keeps the log carefully.

Subsequent flights furnished each its own interest. Only a day or two before starting on that fatal tenth flight, intended to be the last of the series, he wrote as follows to his Weather Bureau colleague, Mr. Herbert Lyman:

> I have had some experiences, I can tell you; some filled with surpassing beauty so far as scenery is concerned; some filled with all the uncertainty and excitement one could possibly ask. In the former category, I would mention our last flight. We passed just at sunrise over the point of Kentucky that juts northward to Covington and Cincinnati. That great bend of the Ohio lay to the north—the valley filled with fog through which twinkled the lights of Cincinnati, and over which shone the red disk of the rising sun. That was exquisite. As for exhilarating excitement, the Hartsburg, Mo., landing takes first rank. Pitch dark; torrential rain; weather so thick the electric lanterns would scarcely reveal the nature of the terrain until we were nearly upon it; a wind of about 25 miles per hour. And we landed—with some violence to be sure—but very neatly in a wheat field a quarter mile from the Missouri River.

His industry and scientific attainments were admirably supplemented by a charming personality—frank, open, and wholesome in every particular. Furthermore, he was an accomplished musician, both as performer and composer. In fact he composed, among other things, his own wedding march, and for several years had been at work on an oratorio, based on the 17th psalm, portions of which already were tentatively completed. Here, too, he worked as a scientist—with the will never to stop until the product was brought to perfection.

We no longer may respond to his cheery "Good morning," nor gladly and profitably consult with him on this or that unsolved problem; yet the example of his buoyant spirit, and resourceful perseverance is ever with us. He so lived that the world is better and wiser because of his having lived. No greater heritage can any man leave than this.—W. J. H.

NOTES, ABSTRACTS, AND REVIEWS

BRAZILIAN MONTHLY WEATHER BULLETIN [1]

The energetic director of the Brazilian Meteorological Service has lost no time in responding to the resolution of the International Meteorological Congress held in Utrecht September last. There has just come to hand the first number of the Brazilian Monthly Weather Bulletin—a four-page large quarto based on telegraphic reports and issued a fortnight after the close of the month to which it refers.

The director is to be congratulated upon the promptness of the appearance of the bulletin and the completeness of the information carried therein.

The text opens with a summary of the atmospheric circulation in the south and central portions of Brazil, and this is followed in order by a synopsis of the weather of the Federal District, the distribution of precipitation in the three great zones—northern, central, and southern—into which the country is divided. Then follows a brief summary of free-air observations as given by records of 10 stations extending from 15° to about 30° south latitude and from 41° to 55° west longitude. The results of free-air observations from the Southern Hemisphere are especially welcome.

A synopsis of the weather as influencing staple crops follows. Numerical values for 63 stations of pressure, temperature, humidity, cloudiness, rainfall, and wind are given and the distribution of rainfall for April is shown on a chart.

[1] Boletim Mensal. Ministerio Da Agricultura, Industria E Commercio, Directoria De Meteorologia, Director: Sampaio Ferraz. Vol. 1, No. 1, April, 1924.

DATES OF GENERAL BREAK-UP OF ICE IN MISSOURI RIVER AT WILLISTON, N. DAK.

[Fort Buford record included.]

By Ross. O. Miller, Observer

Year	Date	Year	Date
1882	Apr. 2	1904	Apr. 5
1883	Apr. 11	1905	Mar. 20
1884	Mar. 24	1906	Mar. 29
1885	Apr. 2	1907	Apr. 5
1886	Apr. 6	1908	Apr. 9
1887	Mar. 11	1909	Apr. 4
1888	Apr. 10	1910	Mar. 10
1889	Mar. 21	1911	Mar. 22
1890	Apr. 5	1912	Apr. 1
1891	Apr. 1	1913	Apr. 2
1892	Apr. 2	1914	Apr. 4
1893	Apr. 2	1915	Apr. 5
1894	Apr. 5	1916	Apr. 3
1895	Mar. 30	1917	Apr. 4
1896	Mar. 29	1918	Mar. 23
1897	Mar. 31	1919	Apr. 4
1898	Apr. 13	1920	Mar. 29
1899	Apr. 9	1921	Mar. 30
1900	[1]	1922	Apr. 8
1901	Mar. 27	1923	Apr. 10
1902	Apr. 6	1924	Apr. 3
1903	Apr. 3		

Average date for 42 years' record, including 1924, April 1: Earliest break-up, March 10, 1910; latest April 13, 1898.

[1] No record.

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SOLAR OBSERVATIONS

SOLAR AND SKY RADIATION MEASUREMENTS DURING MAY, 1924

By HERBERT H. KIMBALL, In Charge, Solar Radiation Investigations

For a description of instruments and exposures and an account of the method of obtaining and reducing the measurements, the reader is referred to the REVIEW for January and February, 1924, **53**; 42 and 113.

From Table 1 it is seen that solar radiation intensities averaged slightly below normal values for May at all three stations.

Table 2 shows that the total solar and sky radiation received on a horizontal surface averaged below normal at Washington and Madison, and above normal at Lincoln.

Skylight polarization measurements made on 9 days at Washington give a mean of 49 per cent, with a maximum of 56 per cent on the 5th. Measurements obtained on 4 days at Madison give a mean of 58 per cent, with a maximum of 64 per cent on the 1st. These are slightly below the average May values at the respective stations.

TABLE 1.—*Solar radiation intensities during May, 1924*

[Gram-calories per minute per square centimeter of normal surface]

Washington, D. C.

Date	Sun's zenith distance										
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.					P. M.				Local mean solar time
	e	5.0	4.0	3.0	2.0	[1]1.0	2.0	3.0	4.0	5.0	e
	mm.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm.
May 1	5.79	-----	0.80	0.92	1.08	-----	-----	-----	-----	-----	4.95
2	5.79	-----	-----	0.84	1.05	1.31	-----	-----	-----	-----	5.36
3	7.87	0.58	0.68	0.81	-----	-----	-----	-----	-----	-----	6.27
5	4.75	-----	0.65	0.81	1.03	1.24	-----	-----	-----	-----	3.99
6	9.14	-----	0.50	0.63	0.80	1.02	-----	-----	-----	-----	11.81
15	7.04	-----	0.69	0.81	1.00	1.35	-----	-----	-----	-----	5.79
17	8.18	-----	0.55	0.67	0.93	1.15	-----	-----	-----	-----	8.48
19	5.79	-----	0.83	-----	0.87	1.10	0.73	0.53	-----	-----	4.57
22	5.56	-----	-----	-----	-----	-----	1.06	0.87	0.72	0.58	4.75
23	8.18	-----	-----	-----	0.85	-----	-----	-----	-----	-----	8.18
26	5.56	0.66	0.77	0.91	1.10	1.39	-----	-----	-----	-----	4.95
31	5.36	-----	-----	-----	1.11	1.33	-----	-----	-----	-----	5.79
Means	-----	(0.62)	0.68	0.80	0.98	1.24	(0.90)	(0.70)	(0.72)	(0.58)	-----
Departures	-----	−0.01	−0.04	−0.03	−0.01	−0.05	−0.08	−0.08	+0.02	−0.03	-----

TABLE 1.—*Solar radiation intensities during May, 1924*—Contd.

Madison, Wisconsin

Date	Sun's zenith distance										
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.					P. M.				Local mean solar time
	e	5.0	4.0	3.0	2.0	[1]1.0	2.0	3.0	4.0	5.0	e
	mm.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm.
May 1	4.57	-----	-----	-----	1.18	1.45	1.18	-----	-----	-----	4.57
2	5.16	-----	-----	-----	-----	1.40	-----	-----	-----	-----	3.81
3	7.04	-----	-----	-----	-----	1.35	-----	-----	-----	-----	4.37
12	6.50	-----	-----	-----	-----	1.26	-----	-----	-----	-----	7.04
15	6.50	-----	-----	-----	1.11	1.37	-----	-----	-----	-----	8.48
20	4.75	-----	-----	-----	-----	1.39	-----	-----	-----	-----	4.75
21	4.17	-----	0.70	-----	-----	1.49	-----	-----	-----	-----	3.00
26	5.36	-----	-----	-----	1.14	-----	-----	-----	-----	-----	5.79
28	5.36	-----	-----	-----	1.05	1.27	-----	-----	-----	-----	6.27
Means	-----	-----	(0.70)	-----	1.12	1.37	(1.18)	-----	-----	-----	-----
Departures	-----	-----	−0.25	-----	+0.00	−0.01	±0.14	-----	-----	-----	-----

Lincoln, Nebr.

Date	e	5.0	4.0	3.0	2.0	[1]1.0	2.0	3.0	4.0	5.0	e
May 1	4.17	-----	0.84	0.96	1.15	1.45	-----	-----	-----	-----	4.17
3	5.79	-----	0.63	0.84	1.09	-----	-----	-----	-----	-----	5.36
12	6.02	-----	-----	0.89	1.06	-----	-----	-----	-----	-----	7.57
13	4.57	-----	-----	0.99	1.14	-----	-----	-----	-----	-----	4.57
16	6.27	-----	-----	0.81	1.06	-----	-----	-----	-----	-----	6.76
22	7.04	-----	0.89	0.99	1.13	-----	-----	-----	-----	-----	7.29
24	4.37	-----	-----	1.07	1.22	-----	-----	-----	-----	-----	3.81
Means	-----	-----	0.79	0.94	1.12	(1.45)	-----	-----	-----	-----	-----
Departures	-----	-----	−0.03	−0.03	−0.03	+0.06	-----	-----	-----	-----	-----

[1] Extrapolated.

TABLE 2.—*Solar and sky radiation received on a horizontal surface*

Week beginning—	Average daily radiation					Average daily departure from normal		
	Washington	Madison	Lincoln	Chicago	New York	Washington	Madison	Lincoln
1924	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.
May 30	497	530	672	434	433	+46	+82	+198
June 7	339	277	403	243	190	−123	−186	−92
14	445	434	547	375	399	−24	−41	+38
21	471	460	532	302	423	−9	−17	+22
Excess or deficiency since first of year on May 27						+644	−4733	+2012

WEATHER OF NORTH AMERICA AND ADJACENT OCEANS

NORTH ATLANTIC OCEAN

By F. A. YOUNG

The following table shows the average sea-level pressure for the month at a number of land stations on the coast and islands of the North Atlantic. The readings are for 8 a. m., 75th meridian time, and the departures are only approximate, as the normals were taken from the Pilot Chart and are based on Greenwich mean noon observations, which correspond to those taken at 7 a. m., 75th meridian time.

Station	Average pressure	Departure
	Inches	*Inches*
St. Johns, Newfoundland	29.91	−0.09
Nantucket	29.87	−0.13
Hatteras	29.92	−0.08
Key West	29.97	−0.02
New Orleans	29.97	+0.02
Swan Island	29.86	−0.01
Turks Island	30.03	+0.03
Bermuda	30.10	+0.02
Horta, Azores	30.18	+0.04
Lerwick, Shetland Islands	29.85	+0.05
Valencia, Ireland	29.80	−0.15
London	29.89	−0.03

It will be noticed that comparatively small departures were the rule at the greater number of stations, including Horta and Bermuda. The Azores HIGH varied considerably during the month, reaching its greatest intensity during the periods from the 6th to 9th and 14th to 16th. The highest barometer readings recorded at Horta were 30.44 inches on the 8th and 30.46 inches on the 15th, and the lowest reading, 29.64 inches on the 20th.

Over the greater part of the ocean there was a decided decrease in the number of days with winds of gale force, as compared with April. Judging from reports received the number of gales along the middle and eastern sections of the northern steamer lanes was somewhat less than the normal shown on the Pilot Chart, while moderate weather was the rule off the European coast. In the territory between the 40th and 45th parallels, and the 40th and 50th meridians, however, heavy winds were more frequent than usual, as they were reported on from 5 to 6 days, and along the American coast in the vicinity of Hatteras, on 4 days.

Fog was unusually prevalent over the region between the 40th and 50th parallels, and the 40th meridian and American coast, the greatest amount occurring in the 5-degree square between the 40th and 45th parallels and the 60th and 65th meridians, where it was recorded on 21 days. Fog was also reported on from 5 to 8 days off the European coast, while the eastern section of the steamer lanes was comparatively clear. No fog was reported from the Gulf of Mexico, which was in marked contrast with April, when it was encountered on 9 days in this region.

On the 1st there were three moderate disturbances over the ocean, the first central near Portland, Me., the second near latitude 47° N., longitude 32° W., and the third about 3 degrees west of the Irish coast. On the 2d the first LOW was near Halifax, N. S., while the second had apparently disappeared, and the third, having decreased in intensity, covered Ireland and the west coast of England.

On the 4th the region between Madeira and Gibralter was occupied by a depression that moved slowly eastward, entering the Mediterranean by the 7th. It reached its greatest intensity on the 5th when a number of vessels between Madeira and the Azores experienced northerly gales. Storm log.

American S. S. *Steel Traveler:*

Gale began on the 4th, wind NE. Lowest barometer 29.75 inches at 8 a. m. on the 4th, wind NE., 4, in latitude 35° 56′ N., longitude 16° 38′ W. End on the 6th, wind N. Highest force of wind 8; shifts NE.-N.

On the 8th there was evidently a well developed disturbance over the eastern section of the steamer lanes, although it was impossible to locate its position on account of lack of observations. Storm log.

British S. S. *Bay State:*

Gale began on the 7th, wind SSE. Lowest barometer 29.61 inches at 8 a. m. on the 8th, wind S., 6, in latitude 55° 39′ N., longitude 20° 44′ W. End on the 8th, wind variable. Highest force of wind 10; shifts S.-W.

On the 9th moderate northwesterly gales prevailed over a limited area near latitude 45° N., longitude 33° W.; this disturbance increased considerably in extent and intensity during the next 24 hours, and by the 10th the storm area extended over a narrow belt between the 40th and 45th parallels and the 25th and 50th meridians, which was swept by westerly winds of force 7 to 11. Storm log.

Italian S. S. *Capena:*

Gale began on the 10th wind SSW. Lowest barometer 29.66 inches at 10 a. m. on the 10th, wind SSW., 11, in latitude 44° 55′ N., longitude 28° W. End on the 10th, wind SSE. Highest force of wind 11; shifts 7 points.

On the 12th a depression covered the middle and eastern sections of the steamer lanes, and vessels between the 48th and 51st parallels and 30th and 40th meridians reported moderate northwesterly gales, accompanied by snow. On the 13th, with no especially well developed low on the map, a few storm reports were received from vessels in widely scattered localities, west of the 35th meridian.

From the 15th to 20th, moderate weather prevailed over the ocean with the following exceptions. On the 15th, near latitude 43° N., longitude 40° W., southerly wind, force 7. 17th, between the 33d and 40th parallels and the 60th and 65th meridians, wind south to west, force 7. 18th, near Bermuda, wind southwest, force 7; latitude 45° N., longitude 43° W., wind west, force 7 with fog. 19th, between 40th and 46th parallels and the 32d and 40th meridians, wind W.-WNW., force 7. 20th, at Father Point, Quebec, wind W., force 7.

On the 21st there was a fairly well developed disturbance central near latitude 55° N., longitude 25° W.; this drifted slowly eastward, and by the 25th surrounded Ireland and the greater part of England, having by that time lost a great deal of its intensity. Storm log.

American S. S. *E. R. Kemp:*

Gale began on the 23d, wind NW. Lowest barometer 29.57 inches at 2 a. m. on the 23d, wind W., 7, in latitude 49° 43′ N., longitude 17° 10′ W. End on the 24th, wind NW. Highest force of wind 9; shifts NW.-W.

On the 23d Sydney, N. S., was near the center of a LOW that on the 25th was central near latitude 50° N., longitude 40° W. On the latter date a second disturbance was off Nantucket that moved northeastward along the coast and reached Newfoundland on the 26th.

Between the 23d and 26th heavy weather prevailed over the western section of the ocean, although a number

of reports was also received from vessels in these waters that experienced moderate conditions. Storm logs.

American S. S. *Balsam:*

Gale began on the 25th, wind S. Lowest barometer 29.67 inches at 6 p. m. on the 25th, wind S., 10, in latitude 39° 24′ N., longitude 64° W. End on the 26th, wind WSW. Highest force of wind 10, S.; shifts S.-SW.-WSW.

Dutch S. S. *Burgerdijk:*

Gale began on the 25th, wind WNW. Lowest barometer 29.91 inches at 2 a. m. on the 25th, wind WNW., 8, in latitude 43° 24′ N., longitude 39° 49′ W. End on the 26th, wind WNW. Highest force of wind 9; shifts WNW.-WSW.

At the time of observation on the 27th, moderate conditions were the rule over the ocean with the following exceptions. Latitude 40° N., longitude 50° W., wind NW., force 7, increased later in the day to SW., 9. Latitude 43° N., longitude 25° W., NW., 7. Latitude 46° N., longitude 36° W., W., 5; increased to NW., 8 at 10 p. m. on the 27th.

Charts VIII to XI cover the period from the 28th to 31st inclusive. Storm logs.

British S. S. *Denham:*

Gale began on the 28th, wind NW. Lowest barometer 29.38 inches at 2.30 a. m. on the 28th, wind NW., 9, in latitude 50° 33′ N., longitude 42° 36′ W. End on the 29th, wind WSW. Highest force of wind 9; shifts S.-SW.-NW.

Belgian S. S. *Elzasier:*

Gale began on the 29th, wind S. Lowest barometer 29.73 inches on the 31st, wind SSW., in latitude 38° 14′ N., longitude 47° 30′ W. End on the 31st, wind SW. Highest force of wind 11; shifts S.-SW.

NORTH PACIFIC OCEAN

By WILLIS E. HURD

The weather of May, like that of the preceding month, was generally rather quiet over the North Pacific. Storms of marked severity were rare, and more trouble perhaps was experienced by vessels from the frequent cloudiness and fog than from any other meteorological source.

Fog showed a considerable increase in percentage over that of April, especially over the eastern half of the ocean where, in higher latitudes, the phenomenon was as frequent as to the westward of the 180th meridian. In both cases it occurred on approximately 50 per cent of the days. Fog was noted on several days along the American coast, particularly to the northward of the 30th parallel, and also reported on a few days along the China coast. Along the northern routes snow fell occasionally, and as late as the 23d the American S. S. *West Himrod* encountered snow squalls in latitude 46° 57′ N., longitude 168° 14′ E., temperature 36°, while on the 24th snow was reported a degree and a half farther south by the American S. S. *Las Vegas*.

In the Hawaiian region the weather was practically normal for the season, except that, as indicated by Honolulu, the rainfall was much less than average. The prevailing wind was east at Honolulu, and the maximum velocity was 31 miles from the east on the 14th.

Pressure distribution over the eastern part of the ocean, as shown by observations at the island stations, was without special significance. At Dutch Harbor the average pressure, based on p. m. observations, was 29.75 inches, or 0.08 inch below normal. The principal deficiency occurred during the period from the 19th to the 29th, inclusive. The highest pressure, 30.16, occurred on the 1st and 15th; the lowest, 29.06, on the 24th. At Midway Island the average pressure was 30.08 inches, or 0.01 inch below normal. The highest reading, 30.26, was recorded on the 12th; the lowest, 29.82, on the 1st. At Honolulu the average, based on p. m. observations, was 30.05 inches, or normal. The highest reading, 30.12, was recorded on the 24th; the lowest, 29.95, on the 6th.

The great areas of high and low pressure—the North Pacific HIGH of western longitudes and the Aleutian LOW—were fairly well developed over the greater part of the month. Both areas fluctuated considerably. The center of the cyclonic disturbance, however, was more frequently east than west of Dutch Harbor, but on the 23d and 24th, the period of its greatest intensity, the center was south of the central Aleutians.

The HIGH was most seriously disturbed from the 12th to the 16th. During this period cyclonic conditions, central at about 45° N., 140° W., entered the area, pushed to the southward apparently by an anticyclone from Alaska. By the 14th the LOW had been forced to about 35° N., 145° W., where it remained until its disappearance on the 16th. The southward-moving anticyclone meanwhile covered the entire Gulf of Alaska and banked along the American coast to the 40th parallel from the 14th until the 17th. On the 18th low pressure again began moving in from the westward and the normal cyclonic and anticyclonic conditions were gradually restored.

In the Far East the continental HIGH disappeared with April, and a succession of LOWS was maintained in Chinese and Japanese waters throughout May. So far as our present data reveal, none of these lows were typhoons, and most if not all of them seem to have been of land origin. The strongest cyclones emanating from this region were those of the 19th–20th over southern Japan and of the 8th, 16th, and 23d to 27th over and to the eastward of northern Japan.

Ship observers reported only two days with gales to the westward of 130° east longitude. One was the 5th, when the American S. S. *Anna E. Morse* fell in with a northeast gale, force 8, pressure 29.80 inches, in 33° 54′ N., 128° E. The other was the 20th, when the British S. S. *Bradford City* encountered a northwest gale, force 8, in 27° 09′ N., 125° 30′ E.

On the 6th to 11th gales occurred over scattered portions of the area bounded by the 40th and 50th parallels, meridian 175° W., and the Japanese coast. This stretch of ocean was the scene of a considerable barometric depression throughout the period. On the 8th the pressure at Nemuro was 29.18. The cyclone producing it advanced into the ocean on the 9th. The maximum wind force was 9, recorded by three vessels as follows: 7th.—British S. S. *Tamaha*, in 47° 50′ N., 178° 39′ W. 9th.—American S. S. *William Campion*, in 46° 07′ N., 154° 32′ E. The latter vessel also recorded at the same time the lowest corrected pressure, 28.60 inches, noted on the ocean for the month. 10th.—American S. S. *Anna E. Morse*, in 43° N., 149° 15′ E., lowest pressure 28.89.

In west longitudes gales not exceeding 8 in force occurred over scattered localities on several dates.

On the 21st and 22d gales of force 8 were experienced by vessels in the neighborhood of 40° N., 150° E. On the 24th to 27th an active cyclone prevailed over and to the eastward of Japan. Reports indicate its greatest intensity to have been on the 24th, on which date the British S. S. *Bradford City* weathered a southerly gale of force 10, in 36° 56′ N., 145° 07′ E. On the 24th and 25th the British S. S. *La Crescenta*, while steaming along the Japanese east coast, hove to for some hours with

engines half speed in a severe easterly changing to northwesterly gale.

The most violent storm of the month was central south of the Aleutian Islands on the 23d and 24th. The American steamships *Dilworth* and *Las Vegas* encountered westerly gales of force 10 in 45° N., 166° to 170° E., lowest pressure about 29.10 inches, on the 23d. On the following day the cyclone intensified and the *Las Vegas* at local noon was in a west-northwesterly gale, force 11, accompanied by rain and snow, in 45° 20′ N., 170° 30′ E. Earlier on the 24th the Canadian S. S. *City of Vancouver* was nearer the center of the disturbance, eastward bound in a whole west gale, lowest pressure 28.73 inches, in 45° 44′ N., 174° 46′ E. This storm by the 25th had merged with the Aleutian LOW and lost greatly in intensity.

No gales were reported from Mexican and Central American coast waters. Calms and light variable winds were frequent, but gentle northwesterly winds prevailed over most of the area.

CYCLONIC DISTURBANCES IN THE NORTH INDIAN OCEAN

By ALBERT J. MCCURDY, JR.

Weather reports received from vessels that traversed the shipping routes of this ocean in May, 1924, indicate that stormy conditions prevailed off the southern coast of India and in the vicinity of Ceylon and the Maldive Islands in the middle decade of the month.

The Dutch S. S. *Yseldijk*, Capt. C. de Korver, proceeding from Rotterdam to Australia, on May 13, encountered a moderate southeasterly gale accompanied by squally weather and rain showers. Mr. D. Treep, observer, states that the lowest pressure observed was 30.03 inches (uncorrected), occurring at 6.03 p. m., in16° 10′ N., 89° 03′ E. This gale lasted for two days and during that time the wind shifted from SE.,to ESE.

On the 15th the American S. S. *West Mahomet*, Capt. H. Milde, Suez bound from Calcutta, ran into a moderate southwesterly gale accompanied by rough seas and overcast skies. Mr. Paul P. Zabeline, observer, reports that the lowest pressure observed was 29.70 inches, occurring at 6 p. m., in 9° 10′ N., 83° E. The wind at this time was SSW., force 7.

The *West Mahomet* encountered its second gale of the month northwest of the Maldive Islands on the 19th, reporting conditions similar to those experienced in the previous storm. The observer reports that at 5 p. m., while in 8° 20′ N., 70° 30′ E., the lowest pressure was recorded, being 29.75 inches. The wind at this time was W., force 7, and by 8 p. m., increased to a fresh gale.

DETAILS OF THE WEATHER IN THE UNITED STATES

GENERAL CONDITIONS

ALFRED J. HENRY

The outstanding feature of the month was the depression in temperature in north-central and northeastern districts and the attendant cloudy, rainy weather which greatly retarded farming operations as noted elsewhere. The temperature distribution—low in the east and high in Pacific coast States—again illustrates the great contrasts that are occasionally experienced on opposite sides of the Rocky Mountains. The usual details follow.

CYCLONES AND ANTICYCLONES

By W. P. DAY

High-pressure areas during May were largely of the Alberta type, some of them moving south-southeast along the eastern slope of the Rockies in a manner not unlike the movement observed in these highs during the colder season.

Pressure was low over middle latitudes east of the Mississippi River from the 6th to the 14th, with several secondary disturbances developing within this area. The most important storms coming out of this area developed considerable intensity on the middle Atlantic coast on the 7th–8th and again on the 11th and 12th.

FREE-AIR SUMMARY

By V. E. JAKL, Meteorologist

The mean free-air temperature for the month was below normal over all aerological stations, the deficiency being much more pronounced over the northern stations than in the South. (See Table 1.) The departure was greatest over Ellendale, where the temperature averaged more than 4°C. below normal to the upper limit of observation, and least over Due West, where it was only a fraction of a degree colder than normal. This is substantially in agreement with Chart III this REVIEW, which shows, for the region east of the Rocky Mountains, negative departures diminishing in general from north to south. The departures were generally quite uniform with altitude, indicating a similarity in source of supply of air at the different altitudes included in the observations. An exception is noted at Royal Center, where the departure increased decidedly with altitude.

The source of supply of air for the different altitudes at each station is well shown in the record of wind resultants for the month determined from kite observations (Table 2), and from the auxiliary record of pilot balloon observations, the resultants from the two classes of observations being in close agreement. There was a definite positive correlation between wind direction and temperature at all levels over Ellendale, Drexel, and Broken Arrow, where a subnormal temperature was associated with winds having a decidedly more northerly trend than usual for the month. Royal Center, to the east of these stations, showed resultant winds that were approximately normal in direction but abnormal in strength. At this station a marked deficiency in temperature occurred in connection with westerly winds that had a slight northerly component in the upper levels and a rather decided southerly component in the lower levels. It is apparent that in the upper levels over Royal Center the air was transported from regions to westward, where abnormally cold northerly winds prevailed. Moreover, the free-air records on the whole indicate what is suggested by the surface observations, viz, a general circulation of the air to at least a few thousand meters depth, from northwestern to eastern sections, in conformity with the average surface pressure gradient. (See Chart VI.) Over Groesbeck and Due West, where the temperature departures were slight, the wind resultants showed no important deviation from normal.

Relative humidities were on the whole somewhat below normal, which, coupled with the lower temperatures that prevailed, indicated a low water content of

the air over most stations. This is well apparent in the record of average vapor pressures (Table 1), and is especially striking for Ellendale and Drexel, where the moisture content of the air averaged less than three-fourths of the normal amount. The northerly winds that prevailed over these two stations were, therefore, quite dry. In this respect, Royal Center was a notable exception, its record showing relative humidities in the upper levels decidedly above normal. At this station also, of all aerological stations, the most frequent precipitation and the most cloudy weather occurred. It is further significant that at Royal Center the largest lapse rate in temperature and the strongest upper-air winds occurred, from which it may be inferred that cold air from the Northwest became most effective in causing precipitation after it reached the eastern States and overran the lower winds that there had a southerly component. (See Chart IV.)

A record at Royal Center rather typical of conditions at that station during the month is that of May 3, when the kite line was struck by lightning. A LOW centered over Lake Michigan covered most of the northeastern portion of the country. Free-air observations showed winds from a west to southwest direction along the Ohio Valley and sections to the east, and northwesterly winds over the western Lake region and upper Mississippi Valley. It is apparent that Royal Center was near the wind shift line, and, from the following report and table, that the charge accumulated in comparatively low clouds. "The first thunder was heard in the west at 9:46 a. m. The storm came up very rapidly and it was impossible to reel the kites in soon enough to escape it. The rain and high wind beat the last secondary kite down to the ground and the others broke loose. This forced the higher kites down into the storm cloud, above which they had been flying, and consequently they were struck by lightning, burning up considerable of the wire beyond the point where the last kite had been forced down to the ground by the storm."

Meterological conditions over Royal Center, Ind., on May 3, 1924

Time	Altitude, M. S. L., meters	Temperature, °C.	Relative humidity, per cent	Wind direction	Wind velocity, m. p. s.
7:24 a. m	225 (surface)	13.0	85	S.	5
8:43 a. m	946	9.3	73	WSW.	19
9:01 a. m	1,833	3.1	92	W.	12
9:19 a. m	2,453	−1.2	92	W.	18
9:23 a. m	2,638	−2.2	47	W.	18
9:31 a. m	3,022	−5.1	71	W.	19
9:38 a. m	3,308	−6.1	55	W.	20

An instance of unusually severe destruction of the kite line by lightning occurred at Broken Arrow on May 28. The following extract from the report of the official in charge at that station and appended table of upper-air conditions give a full description of the circumstances under which the static discharge occurred:

For the third time lightning has struck the kite wire at this station. The latest occurrence was at 9:46 a. m. on May 28, 1924, when almost without warning, the 3,000 meters of wire was fused and 3 kites set free. The flight was started at 8:32 a. m. The sky was overcast with stratus clouds continuously during the flight and the approach of storm clouds could not be observed. There was no premonitory "kicking" of the voltmeter needle as generally precedes thunderstorms. The first thunder was heard in the southwest at 9:39 a. m. only five minutes before the final crash. At 9:38 a. m. an attempt to take voltage resulted in a startling "swish" and the lever was instantly dropped. Reeling in was in progress at this time—the wire burst into flame from the reel to the clouds with a loud explosive noise. Then the flaming pieces of molten metal began to fall and the sound of these shot-like pieces of steel striking the ground could be heard several hundred yards away.

It is recalled that in the case of the last previous stroke there was a side discharge from the reel. Again this time there was a side discharge. The wire, as it passed outward from the reel, was not far from the flood light projector. The large bulb in this light was burned out. Otherwise the light and power circuits were apparently undamaged. The month of May has come to be our most dreaded month for thunderstorms. During May of the preceding two years there were a number of times when the kites were almost caught in an approaching storm. Kites are never put up when thunder is heard, and if up are reeled in as quickly as possible. However, there is no way to avoid such a stroke as occurred on the 28th.

Meteorological conditions over Broken Arrow, Okla., on May 28, 1924

Time	Altitude, M. S. L. meters	Temperature °C.	Relative humidity, per cent	Wind direction	Wind velocity m. p. s.
8:32 a. m	233 (surface)	15.0	94	NE.	7
8:45 a. m	608	12.9	95	ENE.	6
8:53 a. m	880	17.1	94	ESE.	8
9:02 a. m	1,703	14.9	90	SSW.	15
9:23 a. m	2,600	11.5	70	WSW.	21
9:28 a. m	2,739	10.5	55	WSW.	22
9:36 a. m	2,600	9.4	100	WSW.	22

The intensity of the discharge can be judged from the circumstance of the incandescent light filaments having been burned out, although they were not in metallic connection with the kite wire. The record of wind direction during this kite flight is typical of certain forms of pressure distribution, where low pressure lies to the south or southwest, and high pressure to the north or northeast. A trough of low pressure extended from the Ohio Valley southwestward to Texas, and relatively high pressure prevailed over the middle and northern Plains States. The greatest change in temperature occurred above 1,700 meters, where the wind veered with altitude from SSW to WSW. In this region, previously comparatively dry, the temperature fell and cloudiness increased rapidly, as will be noted by the record at 9:37 a. m., which shows a lower temperature and higher humidity at 2,600 meters than a few minutes before. The discharge can undoubtedly be attributed to the effect of pronounced convectional activity extending above 1,700 meters to some unknown height, as the record of surface conditions shows a brief shower of rain and hail occurring soon after the discharge took place.

Winds from an easterly direction at high altitudes occurred at many stations on scattered dates throughout the month. In nearly all cases these winds occurred in a more or less stratified state, superimposed upon, or surmounted by, winds of other directions. Moreover, they were of light velocity, indicating that as a rule they were merely incidental to the conditions of light winds and variable direction with altitude that frequently accompany ill-defined pressure distribution. An example of deep easterly winds prevailing over a rather extended period, however, is furnished in the records of the Key West station, where pilot-balloon observations showed winds having an easterly component to altitudes as high as 10,000 meters, prevailing almost continuously from the 26th to 31st. These winds were probably not unusual for that latitude, and appeared to be associated with the position of the Atlantic HIGH, which lay farther south during this period than earlier in the month.

TABLE 1.—*Free-air temperatures, humidities, and vapor pressures during May, 1924*

TEMPERATURE (°C.)

Altitude. m. s. l. (m.)	Broken Arrow, Okla. (233 m.)		Drexel, Nebr. (396 m.)		Due West, S. C. (217 m.)		Ellendale, N. Dak. (444 m.)		Groesbeck, Tex. (141 m.)		Royal Center, Ind. (225 m.)	
	Mean	Departure from 6-yr. mean	Mean	Departure from 9-yr. mean	Mean	Departure from 4-yr. mean	Mean	Departure from 7-yr. mean	Mean	Departure from 6-yr. mean	Mean	Departure from 6-yr. mean
Surface	16.4	−3.0	13.1	−2.8	20.2	−0.2	9.5	−3.4	21.1	−1.6	14.4	−2.2
250	16.3	−3.0			19.9	−0.2			20.2	−1.6	14.2	−2.1
500	14.5	−2.9	12.4	−2.8	17.9	+0.1	9.1	−3.5	18.3	−1.7	11.8	−2.0
750	13.3	−2.6	10.8	−2.7	16.2	+0.2	7.1	−3.9	17.0	−1.6	9.4	−2.5
1,000	12.4	−2.3	9.2	−2.8	14.4	−0.1	5.4	−4.1	16.1	−1.2	7.5	−2.8
1,250	11.1	−2.4	7.9	−2.7	12.9	−0.1	4.0	−4.1	15.2	−1.0	5.6	−3.1
1,500	9.8	−2.5	6.6	−2.5	11.3	−0.2	2.5	−4.1	14.1	−1.0	3.7	−3.5
2,000	7.1	−2.6	4.2	−2.3	9.2	+0.2	−0.3	−4.0	11.8	−1.0	0.5	−4.1
2,500	5.3	−1.8	1.7	−2.1	5.9	−0.3	−3.4	−4.2	9.5	−0.7	−1.9	−4.0
3,000	2.5	−1.6	−0.6	−1.5	3.0	−0.4	−6.4	−4.4	7.3	−0.2	−4.8	−4.1
3,500	−0.4	−1.7	−3.3	−1.3	0.1	−0.5	−9.2	−4.6	4.4	−0.1	−8.2	−4.6
4,000	−3.9	−2.0	−6.1	−1.1	−3.3	−0.8	−12.3	−4.7	1.4	−0.1		
4,500	−7.1	−2.0	−8.1	−0.1	−6.9	−1.2	−16.0	−5.5				
5,000			−10.3	+0.9	−9.7	−0.6	−19.2	−6.3				

RELATIVE HUMIDITY (%)

Altitude. m. s. l. (m.)	Broken Arrow Mean	Departure	Drexel Mean	Departure	Due West Mean	Departure	Ellendale Mean	Departure	Groesbeck Mean	Departure	Royal Center Mean	Departure
Surface	68	−5	60	−5	61	−4	57	−5	71	−1	67	+4
250	68	−5			61	−4			72	0	67	+4
500	66	−6	59	−5	61	−4	57	−5	74	+1	66	+3
750	64	−8	58	−5	61	−5	57	−4	75	+3	68	+5
1,000	64	−7	58	−4	62	−4	58	−3	72	+2	70	+8
1,250	62	−7	58	−4	62	−4	58	−4	66	0	72	+10
1,500	61	−5	58	−4	63	−3	58	−4	63	+1	77	+15
2,000	61	−2	55	−4	56	−7	59	−3	60	+5	76	+17
2,500	54	−5	56	−1	51	−10	62	+1	57	+5	70	+16
3,000	51	−4	52	−5	42	−14	60	+1	53	+3	64	+14
3,500	50	−3	49	−7	37	−14	57	+3	49	+2	75	+26
4,000	52	−1	59	+3	33	−12	54	+1	49	+3		
4,500	56	−1	61	+3	32	−9	64	+9				
5,000			60	0	30	−11	67	+16				

TABLE 1.—*Free-air temperatures, humidities, and vapor pressures during May, 1924*—Continued

VAPOR PRESSURE (mb.)

Altitude. m. s. l. (m.)	Broken Arrow, Okla. (233 m.)		Drexel, Nebr. (396 m.)		Due West, S. C. (217 m.)		Ellendale, N. Dak. (444 m.)		Groesbeck, Tex. (141 m.)		Royal Center, Ind. (225 m.)	
	Mean	Departure from 6-yr. mean	Mean	Departure from 9-yr. mean	Mean	Departure from 4-yr. mean	Mean	Departure from 7-yr. mean	Mean	Departure from 6-yr. mean	Mean	Departure from 6-yr. mean
Surface	13.02	−3.70	8.81	−3.15	14.88	−0.82	6.23	−3.19	17.87	−2.01	11.06	−0.92
250	12.88	−3.69			14.64	−0.78			17.24	−1.81	10.86	−0.90
500	11.12	−3.46	8.25	−3.06	13.03	−0.58	6.05	−3.12	15.85	−1.37	9.09	−0.92
750	10.09	−3.01	7.20	−2.77	11.72	−0.64	5.36	−2.70	14.96	−0.63	8.11	−0.72
1,000	9.44	−2.52	6.50	−2.50	10.47	−0.75	4.87	−2.42	13.37	−0.60	7.28	−0.63
1,250	8.45	−2.30	6.01	−2.15	9.44	−0.74	4.50	−2.20	11.35	−0.85	6.73	−0.38
1,500	7.59	−1.81	5.56	−1.80	8.44	−0.74	4.13	−1.96	9.70	−0.89	6.24	−0.11
2,000	6.28	−1.24	4.44	−1.38	6.26	−1.14	3.43	−1.43	7.84	−0.19	4.74	−0.14
2,500	4.82	−0.98	3.77	−0.92	4.36	−1.64	2.86	−0.95	6.63	+0.23	3.70	+0.09
3,000	3.86	−0.62	2.92	−0.89	2.79	−1.93	2.19	−0.80	5.51	+0.21	2.87	+0.30
3,500	3.12	−0.61	2.12	−0.92	1.81	−1.97	1.58	−0.67	4.55	+0.33	2.97	+0.93
4,000	2.62	−0.53	1.86	−0.57	1.14	−1.85	1.13	−0.58	3.90	+0.39		
4,500	2.28	−0.53	1.40	−0.61	0.64	−1.64	0.74	−0.48				
5,000			1.04	−0.63	0.31	−1.59	0.29	−0.53				

TABLE 2.—*Free-air resultant winds (m. p. s.) during May, 1924*

RESULTANT WIND DIRECTION AND VELOCITY (m. p. s.)

Altitude. m. s. l. (m.)	Broken Arrow, Okla. (233 meters) Mean		6-year mean		Drexel, Nebr. (396 meters) Mean		9-year mean		Due West, S. C. (217 meters) Mean		4-year mean		Ellendale, N. Dak. (444 meters) Mean		7-year mean		Groesbeck, Tex. (141 meters) Mean		6-year mean		Royal Center, Ind. (225 meters) Mean		6-year mean	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
Surface	N. 67° W.	1.0	S. 21° E.	1.6	N. 50° W.	2.6	S. 8° W.	1.1	S. 69° W.	3.9	S. 62° W.	0.3	N. 10° W.	5.4	N. 33° E.	0.6	S. 10° E.	2.2	S. 15° E.	2.0	S. 83° W.	3.5	N. 44° E.	0.4
250	N. 71° W.	0.8	S. 22° E.	1.6					S. 68° W.	4.2	S. 61° W.	0.5					S. 9° E.	2.6	S. 10° E.	2.5	S. 81° W.	3.6	N. 48° E.	0.4
500	S. 85° W.	2.0	S. 12° E.	2.3	N. 47° W.	3.7	S. 12° W.	1.1	S. 73° W.	6.0	S. 80° W.	0.7	N. 9° W.	5.6	N. 46° E.	0.4	S. 5° E.	3.5	S. 3° E.	3.6	S. 69° W.	6.2	S. 51° W.	0.1
750	N. 89° W.	1.4	S. 3° E.	2.7	N. 44° W.	5.6	S. 21° W.	1.2	S. 75° W.	7.1	S. 74° W.	1.2	N.	5.6	S. 60° E.	0.5	S. 5° W.	4.0	S. 7° W.	4.1	S. 68° W.	7.3	S. 74° W.	0.6
1,000	S. 88° W.	2.1	S. 14° W.	2.9	N. 48° W.	7.4	S. 43° W.	1.8	S. 79° W.	7.4	S. 84° W.	1.7	N. 5° W.	5.6	S. 18° E.	0.7	S. 18° W.	4.2	S. 20° W.	4.6	S. 73° W.	8.9	W.	1.2
1,250	N. 81° W.	2.9	S. 33° W.	3.0	N. 51° W.	8.4	S. 53° W.	2.3	S. 82° W.	8.4	S. 76° W.	2.8	N. 6° W.	5.7	S. 8° W.	1.0	S. 34° W.	4.1	S. 28° W.	4.9	S. 75° W.	8.7	N. 77° W.	1.6
1,500	N. 79° W.	3.9	S. 44° W.	3.3	N. 53° W.	9.5	S. 61° W.	3.0	S. 84° W.	10.1	S. 72° W.	4.0	N. 16° W.	6.2	S. 24° W.	1.4	S. 48° W.	3.9	S. 38° W.	4.8	S. 82° W.	8.6	N. 80° W.	2.2
2,000	N. 62° W.	6.2	S. 67° W.	4.0	N. 54° W.	11.1	S. 74° W.	4.2	S. 87° W.	11.8	S. 78° W.	5.3	N. 29° W.	7.0	S. 45° W.	2.3	S. 62° W.	3.6	S. 50° W.	4.8	N. 88° W.	9.6	N. 84° W.	3.2
2,500	N. 65° W.	9.6	S. 87° W.	5.3	N. 59° W.	11.6	S. 82° W.	4.9	N. 89° W.	12.8	S. 83° W.	6.7	N. 43° W.	7.9	S. 50° W.	3.8	S. 82° W.	4.8	S. 67° W.	5.4	N. 87° W.	11.7	N. 84° W.	4.2
3,000	N. 66° W.	11.4	N. 81° W.	6.5	N. 62° W.	13.2	S. 85° W.	7.1	S. 82° W.	13.5	W.	6.4	N. 48° W.	9.3	S. 60° W.	5.0	N. 75° W.	7.4	S. 81° W.	6.9	N. 85° W.	14.4	N. 81° W.	5.5
3,500	N. 72° W.	12.7	N. 74° W.	9.3	N. 62° W.	12.6	S. 89° W.	8.2	S. 82° W.	14.4	N. 83° W.	8.4	N. 55° W.	10.4	S. 72° W.	5.0	N. 65° W.	13.0	N. 88° W.	8.6	N. 84° W.	16.6	N. 69° W.	6.8
4,000	N. 83° W.	12.0	N. 67° W.	11.3	N. 85° W.	11.8	N. 84° W.	8.9	S. 85° W.	15.0	N. 75° W.	10.8	N. 51° W.	11.0	S. 83° W.	5.0	N. 56° W.	13.8	N. 66° W.	12.2				
4,500	N. 72° W.	17.9	N. 65° W.	17.9	N. 79° W.	13.5	S. 78° W.	10.5	W.	13.7	N. 69° W.	10.4	N. 45° W.	10.9	N. 76° W.	3.3	N. 45° W.	18.8	N. 59° W.	14.1				
5,000	N. 45° W.	26.0	N. 45° W.	26.0	N. 75° W.	14.6	N. 86° W.	16.0	W.	14.0	N. 80° W.	15.3	N. 67° W.	14.1	N. 45° E.	3.3								

THE WEATHER ELEMENTS

By P. C. DAY, Meteorologist, in Charge of Division

PRESSURE AND WINDS

The marked persistence of low atmospheric pressure, and the frequency of moderate cyclonic conditions over the districts from Mississippi Valley eastward, and the movement southward from Alberta along the eastern slopes of the Rocky Mountains and over the Great Plains of several anticyclones, favored the prevalence of northerly and westerly winds over much of the country from the Rocky Mountains eastward. As a result of this inflow of air from higher latitudes or more elevated regions the weather continued cold over the districts between the Rocky Mountains and the Mississippi Valley, and almost constant cold, cloudy, rainy weather prevailed during the month over much of the country from the Mississippi Valley eastward.

The most important cyclone of the month in its general effect upon the weather first assumed prominence in the lower Missouri Valley on the morning of the 5th, and, with secondary disturbances that developed within the main low pressure area, or that combined with it in its slow eastward movement, dominated the weather over the districts from the Mississippi Valley eastward until after the end of the first decade. During this

period showers were of almost daily occurrence over large areas of the central and eastern districts, and heavy rains occurred locally in many sections.

Closely following this period, showers again set in over the upper Mississippi Valley about the 13th and gradually overspread much of the country to the eastward and southward during the following two or three days.

The next important cyclonic area overspread the Missouri Valley and Middle Plains on the 23d and during the 24th and 25th extended into nearly all portions of the country from the Mississippi River eastward, heavy rains being reported locally from points in the middle Mississippi Valley and Great Lakes region, and moderate showers elsewhere.

During the period from the 26th to 30th rather feeble cyclonic conditions existed over the interior districts from the southern Plains eastward, with attending thundershowers, local heavy rains, and occasional storms of tornadic character, some quite severe, particularly during the 26th and 27th in portions of the States from Mississippi to South Carolina, and again on the 28th at points in Oklahoma and Arkansas. Loss of human life from these storms amounted to more than 50, many more were injured, and much property damage was sustained. The details of these will be found in the table of severe storms.

For the month as a whole pressure was below normal over all districts of the United States and Canada from the Great Plains and upper Lake region eastward. Pressure averages were also below normal in California and adjacent portions of the Southwest.

Pressure averages were higher than normal over the Rocky Mountain and adjacent areas and in the far Northwest.

The wind circulation was materially influenced by the persistent low pressure over eastern districts and by the somewhat permanent high pressure over the eastern slope of the Rocky Mountains, the result being northwesterly to southwesterly winds over much of the interior and northern portions of the country.

High winds were not prevalent over extensive areas on any particular date as a rule, but many severe storms of local character, particularly hailstorms, were reported, and local damage to crops was severe in some cases. Reference to these may also be found in the table of severe storms.

TEMPERATURE

The month as a whole stands out conspicuously among the cold Mays of the past half century or more, from the Rocky Mountains eastward. Indeed, in portions of the central valleys the month was the coldest in the recorded weather history, and in many other sections it closely contested the records of May, 1907 and 1917, both of which were months of unusual cold.

On the other hand the far western part of the country experienced during the same period unusual warmth, and there new bounds were set for high average temperatures, which exceeded any observed in May during the past half century or more.

In the main, the low mean temperatures over the eastern two-thirds of the country were not the result of periods of excessive cold, as only in a few instances were the records of low temperature of previous years broken, but were due to continued moderate coolness brought about by the cyclonic circulation or by the presence of cloudy, rainy weather and the resultant coldness of the earth's surface. In portions of the Lake region and other nearby localities only a few days had temperatures above normal, and in some cases not more than one day during the month was warmer than normal.

In the far West the general absence of clouds or rain, and the dry and heated condition of the soil greatly favored the accumulation of heat in the atmosphere. Here too the heat was nearly continuous, some stations reporting not more than two days with temperature below the normal.

All the weeks of the month had temperatures below normal over some portions of the central valleys and eastern districts and all had temperatures above normal over the greater part of the far West. The period of greatest contrast was during the last decade when temperatures ranged from 6° to 15° below normal in portions of the Great Plains and adjacent areas, while in the Pacific coast States the averages were nearly as much above the normal.

The principal periods of high temperatures were the 5th to 7th from the northern Plains eastward to the Atlantic coast; about the 17th to 19th over the Southwest and far West; and the 26th to 29th in the Gulf States.

The lowest temperatures were mainly during the first decade over the districts from the Rocky Mountains westward, and from the upper Lakes eastward, and in portions of the Gulf States; near the beginning of the second decade in the west Gulf States; and during the early part of the last decade in portions of the Ohio Valley.

Temperatures reached the freezing point or lower in most localities north of the Ohio River and in the mountain regions to the eastward as far south as the Carolinas. West of the Mississippi temperatures as low as 32° were observed in all States except Louisiana and Texas, although the lower elevations of the Southwest and the Pacific coast districts were generally without frost.

The average temperatures of the month were below normal over all portions of the United States and Canada from the Rocky Mountains eastward, the regions of greatest deficiency embracing the Ohio, middle and upper Mississippi, and lower Missouri Valleys, and most of the Great Plains area.

West of the Rocky Mountains the average temperatures were everywhere above normal, the greatest excesses being reported from the Plateau region, where they ranged from 6° to 9°.

PRECIPITATION

Considering the country as a whole probably two-thirds of the area had deficient precipitation as compared with the usual fall for the month. However, the eastern third had amounts in many cases far in excess of the normal, and in portions of the Middle Atlantic States precipitation was of almost daily occurrence, and the soil remained too wet for cultivation throughout practically the entire month. In the upper portions of the Potomac River watershed the precipitation for the month ranged up to 10 or 12 inches, being particularly heavy about the 10th to 12th and resulting in one of the severest floods in recent years over the middle and lower portions of the river, the details concerning which will be found elsewhere in this issue. Over other sections east of the Mississippi the precipitation was mainly above the normal, though there was a distinct shortage over portions of the Southeastern States, notably Florida, where in the vicinity of Jacksonville it was the driest May in 50 years.

West of the Mississippi River, except in Louisiana and portions of Missouri and Texas, and locally in the middle

Rocky Mountain region, the precipitation was everywhere less than normal and the deficiency was large and detrimental to crop growth over much of the upper Mississippi and lower Missouri Valleys and Middle Plains region, where it was among, and in some cases, the driest ever experienced in May.

Farther west, particularly over the Pacific coast sections, the deficiency in precipitation, which has persisted locally for many months, continued, and in many portions of California, Nevada, Oregon, and Washington and nearby sections of other States it was the driest May of record. At Eureka, Calif., May was the eighth consecutive month with precipitation below normal, and the total deficiency since the first of the year was nearly 20 inches. Similar conditions exist in other portions of California, also in Oregon and Nevada.

Due to deficient snowfall during the past winter over much of this region, and to its early melting on account of the high temperatures, the rivers in many sections are at the lowest stages ever known and steps are already being taken to conserve the diminishing water supplies.

SNOWFALL

Some heavy snows fell during the month in the middle Rocky Mountain States, particularly near the end, the depths ranging up to 50 inches or more at some of the more elevated points. Elsewhere in the Rocky Mountain system there was little or no snowfall, and no measurable amounts occurred in the mountains of California and Nevada, and that on the ground from previous months had practically disappeared. On some of the more elevated districts where the snow usually lies until July, it had all disappeared early in May. Snowfall was reported from most northern districts at some time during the month and some rather heavy falls occurred from Montana to the upper Lakes near the middle of the first decade.

RELATIVE HUMIDITY

Despite the generally cool weather during the month over the districts east of the Rocky Mountains, and the cloudy, rainy conditions over the more eastern districts, the percentage of relative humidity over the greater part of this territory was less than normal. In the Northeastern States, however, there was a general, though mainly slight excess, and local averages slightly above normal occurred elsewhere, notably on the eastern slopes of the middle and southern Rocky Mountains. Over the Plateau and Pacific coast States there were general and frequently large deficiencies in the percentage of relative humidity, which would be expected in view of the high temperatures and general lack of precipitation.

Much cloudy, rainy weather prevailed over the northern and central portions of the country from the Mississippi Valley eastward, some sections having less than one-third the possible amount of sunshine. Elsewhere sunshine was usually sufficient.

SEVERE LOCAL HAIL AND WIND STORMS, MAY, 1924

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A more complete statement will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path (yards)[1]	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Peabody (near), Kans.	2					Heavy hail	Damage not reported	Official, U. S. Weather Bureau.
Fort Bayard, N. Mex.	2	12:10-12:30 p. m.	2 mi.		$4,000	Damaging hail	Considerable damage to fruits, path 5 miles long.	Do.
Indianapolis, Ind.	3					Thunderstorm with wind and hail.	Considerable damage to plants and window panes.	Do.
Seneca County, Ohio. (s. w. part of).	3	p. m.				Tornadic wind	Heavy property damage	Do.
Cocoanut Grove, Fla.	4					Heavy hail	Minor damage	Do.
Boone County, Mo.	5			2		Thunderstorm	School boy of Columbia and farmer near Centralia killed by lightning.	Do.
Upland, Nev.	6	5-6 p. m.	1,200			Hail	About 75 per cent of fruit crop and gardens damaged. Path 10 miles long.	Do.
Idlewild, Tenn.	6			1		Electrical	Farmer and horse killed by lightning	Do.
Dongola, Ill.	6				3,000	Hail	Crops damaged	Do.
Grant County, Ky. (n. part of).	7	2 p. m.	1,760			Heavy hail	Early garden truck damaged. Path several miles long.	Do.
St. Marys Ohio, (vicinity of)	7					Wind	Electric light and trolley poles blown down	Do.
Bradshaw, Tex.	8	7 p. m.	3.5 mi.			Hail	Entire loss of seed planted	Do.
Mercedes, Tex.	8	6 p. m.	880		5,000	Heavy hail	Roofs damaged. Greater part of storm over unproductive land. Path 2 miles long.	Do.
Trezevant (near), Tenn.	8					Wind, rain, and hail	Farm lands washed, fruit trees uprooted, peaches and strawberries injured.	Do.
Marquette County, Mich.	8-9				10,000	Glaze	Damage principally to telegraph and telephone poles and wires.	Do.
Seguin, Tex.	9	1 a. m.	6-7 mi.			Heavy hail	All cotton in 100 square miles destroyed; corn suffered and oats destroyed.	Do.
New Braunfels, Tex.	9	1:50 a. m.	12 mi.			Hail	Window panes broken; fruit entirely destroyed, Stones were the size of walnuts.	Do.
Corpus Christi, Tex.	10	1:10 a. m.			15,000	do	Damage confined mostly to windows, roofs, and garden truck.	Do.
Mayesville, S. C.	11	7:15 p. m.	33		5,000	Tornado	Character of damage not reported. Short path.	Do.
Vega, Tex.	11	6 p. m.	4 mi.		10,000	Hail and electrical.	Heavy damage; also some stock killed by lightning. Length of path 18 miles.	Do.
Clairemont, Tex.	12	2:30 p. m.	1-5 mi.			Heavy hail	Small crops total loss. Some roofs damaged	Do.
Hermleigh, Tex.	12	6 p. m.				do	Total loss of crops. Severe damage to houses, fruit, etc.	Do.
Jayton, Tex.	12	4 p. m.	2 mi.			do	All buildings in path severely damaged	Do.
Jayton, Tex.	13	7 p. m.	13.5 mi.			do	do	Do.
Hermleigh, Tex.	13	10:30 p. m.	3 mi.			do	Total loss of crops. Buildings, fruit, etc., damaged.	Do.
Abilene, Tex.	13	11 p. m.	2-3 mi.		10,000	do	Considerable damage. Path 5 miles long.	Do.
Plainview, Tex.	13	During night.	3 mi.		25,000	do	Crop loss varies from 6 per cent to total. Length of path 4 miles.	Do.
Sylvester, Tex.	13	9 p. m.	8 mi.		100,000	do	Buildings and crops severely damaged. Path 12 miles long.	Do.
McCaulley, Tex.	13	8:10 p. m.	2-5 mi.		50,000	do	Total loss of crops; houses considerably damaged and poultry injured.	Do.
Beeville, Tex.	14	12 mdnt.	4 mi.		5,000	do	Extensive area of cotton and corn damaged	Do.
Nixon, Tex.	14	9 p. m.				do	About 5,000 acres of corn and cotton destroyed	Do.

[1] mi. signifies miles, instead of yards.

Severe local hail and wind storms, May, 1924—Continued

Place	Date	Time	Width of path (yards)[1]	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
St. George, Ga	15					Heavy hail	Much damage to fruit, roofs, and window panes.	Official U. S. Weather Bureau.
Brady's Bend, Pa. (and vicinity.	18	9:30 a. m.				do	Injury to garden truck	Do.
Temple Hill and Game, Ky.	19	3 p. m.	4 mi.		5,000	do	Crops damaged	Do.
Havana (near), Kans	19	5 p. m.				do	Extent of damage not known. Considered one of the most severe storms ever known locally.	Do.
Seymour, Mo	19		880			Thunderstorm and hail.	Large trees uprooted, houses and barns demolished, crops hurt. Path 5 miles long.	Do.
Greene and Webster Counties, Mo. (n. part of).	19					Wind and hail	All fruit, wheat, and corn in path ruined. Hail confined to northeast part of Greene County.	Do.
Blaine and Canadian Counties, Okla.	19	P. m.			2,500	Hail	Damage not reported	Do.
Lawton, Okla. (10 miles ne. of).	19					do	Wheat, corn, oats, and cotton on several farms ruined.	Do.
Rockingham, Caswell, Warren, and Halifax Counties, N. C. (parts of).	20		3-4 mi.			Heavy hail	Extensive crop damage	Do.
Abbott, N. Mex. (4 miles north of).	20		1,760			Hail	Minor damage. Storm over sparsely settled country.	Do.
Dallas County, Tex. (s. portion of).	20	3:30-4:30				Hail and wind	60 per cent crop loss reported	Do.
Kaufman, Tex. (2 miles east of).	20	5:30 p. m.	50		50,000	Tornado and hail	Livestock injured and buildings and crops damaged; 2 persons injured. Path 7 miles long.	Do.
Flint, Tex	20	6 p. m.	1-2 mi.			Hail	Estimated 50 per cent of tomato crop ruined. Path 5 miles long.	Do.
Coleman, Tex	20	4 p. m.	3 mi.		10,000	Heavy hail	Crops ruined and some poultry killed. Path 30 miles long.	Do.
Milan, Tenn., and vicinity	20					Electrical and wind.	One barn burned, 4 others and some trees blown down.	Do.
Springer, N. Mex	21					Heavy hail	Extent of damage not reported	Do.
Cheyenne, Wyo	22		3 mi.			do	No material damage reported	Do.
Buckingham, Fla	23		2 mi.		5,000-6,000	Moderate hail	Considerable damage	Do.
McLeansboro, Ill	23				8,000	Wind	Buildings, trees, and wires damaged; 2 persons injured.	Do.
Waterloo, Ill	23				15,000	do	Considerable property damage	Do.
Southeastern Missouri	23			1		Electrical, wind, and hail.	Extensive crop damage; 7 persons injured	Do.
St. Louis (city) and St. Charles County, Mo.	23					Thunderstorm and wind.	Damage principally to wires and trees	Do.
Charity, Mo	23					Wind, rain, and hail.	Houses and barns damaged; nearly a total loss of crops in path of hail. Hail 18 inches in some places.	Do.
Fayetteville, Ark., and vicinity.	23	p. m.			2,500	Wind	Grounds and buildings of university damaged. Minor damage in vicinity.	Southwest Times Record (Fort Smith, Ark.).
Elkhart (near), Kans	23	3-4 p. m.	10 mi.		10,000	Heavy hail	Character of damage not reported	Official, U. S. Weather Bureau.
Marion and Chase Counties, Kans.	23	2 p. m.	4 to 8 mi.			Hail	Considerable damage to wheat, alfalfa, and fruit.	Do.
Morris County, Kans	23	1 p. m.	4 mi.			do	Wheat and other crops beaten to ground	Do.
Pomona (near), Kans	23	2-2:30 p.m.				do	Gardens and fruits damaged	Do.
LeRoy (near), Kans	23	3:30-4 p.m.	2,640		20,000	do	Roofs damaged and poultry killed	Do.
Fort Smith, Ark	23	6:41 p. m.				Thunderstorm	General damage done	Do.
Hartford, Conn., and vicinity	24					High winds	Trees and wires down, trolley service delayed, telephones out of order; crop loss heavy; 1 person injured.	Do. Hartford Courant (Conn.).
Hall and Jackson Counties, Ga.	24				1,000	Hail	Crops injured	Official, U. S. Weather Bureau.
Tuscola, Tex	25	8 p. m.	10 mi.		40,000	Hail and rain	Considerable crop damage. Path 12 miles	Do.
Imperial, Tex	25	5 p. m.	3 mi.		10,000	Hail	Crops suffer; other minor damage. Path 10 miles long.	Do.
Eastland, Tex	26	10 p. m.	2 mi.		1,000	do	Some damage to fruit and buildings. Path 4 miles long.	Do.
Red Oak, Tex	26	A. m.				High wind	Two seed houses wrecked	Dallas Morning News (Tex.)
Hubbard, Tex	26	A. m.				Tornado (probably).	Eleven buildings demolished	Do.
Vicksburg, Miss	26	1:45 p. m.				Thunderstorm	Several dwellings and a number of trees damaged; electric current cut off in many parts of the city.	Official, U. S. Weather Bureau.
Leland (near), Miss	26	P. m.		3		Tornado	Path several hundred yards wide; 17 persons injured and about 20 houses destroyed.	Daily States (New Orleans, La.).
Elkmont (near), Ala	26	11:45 p. m.		8	5,000	do	Minor property damage	Official, U. S. Weather Bureau.
Summit to Brewer, Miss	26-27	11 p. m.-1:15 a.m.		12		do	Heavy property loss and a number of persons injured.	Do.
Lee County, Miss., to Marion County, Ala.	27	a. m.	1,760	3		do	Five persons hurt; 4 houses destroyed; numerous buildings damaged.	Meridian Star (Miss.) Official U. S. Weather Bureau.
Noxubee County, Miss., to Pickens County, Ala.	27	a. m.	1,760	2	10,000	do	Several hurt; 3 stores and many houses wrecked.	Do.
Bay Springs to Increase, Miss.	27	12:40 a. m.	150-200	3		do	Eight injured; several houses destroyed	Official, U. S. Weather Bureau.
Moselle to Waynesboro, Miss.	27	3 a. m.		2		do	Four persons hurt and much property damaged	Official, U. S. Weather Bureau; MeridianStar (Miss.).
Empire (near) to White Springs, Ala.	27	2:15-4 30 a. m.	440	11		do	Damage near Empire $19,000; considerable at White Springs. Fifteen persons injured	Official, U. S. Weather Bureau.
Burnsville, Ala	27	3:40 a. m.			3,000	do	Nine houses destroyed and 2 persons slightly injured.	Official, U. S. Weather Bureau; Advertiser (Montgomery, Ala.).
Florence (near), to Smithboro (near), S. C.	27	p. m	100-300		18,000	do	Four buildings wrecked and 2 persons injured.	Official, U. S. Weather Bureau.
Eureka (near) to St. Matthews (near), S. C.	27	p. m.	30-800		22,000	do	Two persons injured and some property damage.	Do.
Fredonia (near) to Neodesha (near), Kans.	27	6:30 p. m.				Hail	Crops laid waste and trees uprooted	Do.
Alden (near), Kans	27	12:30 p. m.				do	Wheat damaged as much as 75 per cent in places. Fruit also damaged.	Do.
Southern part of Barton and northern part of Stafford Counties, Kans.	27	p. m				do	Considerable damage to wheat; in places ground covered 3 to 4 inches with hail.	Do.
Wichita (near), Kans	27	4-5 p. m.	4 mi.		75,000	do	Great damage to fruit	Do.
Rowland (near), N. C	27	12:30 p. m.	100-300		5,000	Wind	Several barns razed; timber damaged	Do.
Stringtown, Okla. (5 miles nw. of).	27	9 p. m.		5	4,000	do	Some property damage and 2 persons injured	Do.

[1] mi. signifies miles, instead of yards.

Severe local hail and wind storms, May, 1924—Continued

Place	Date	Time	Width of path (yards)[1]	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Fort Smith, Ark	27	P. m.			50,000–75,000	High wind	Heavy property damage. Fort Smith Light and Traction Company probably heaviest losers.	Official U. S. Weather Bureau.
Watts, Okla	27	7 p. m.	2–3 mi			Heavy hail	Considerable property damage	Do.
Do	28	7 p. m.	2–3 mi			do	do	Do.
Wetumka to Warner, Okla	28	5:30–6.15 p. m.	133–1,760	9	190,000	Tornado	Heavy property damage; 37 persons injured	Do
Stigler, Okla., to Fort Smith, Ark.	28	7 p. m.	300–150	5	91,000	do	Heavy property and crop damage; 15 houses at Gans wrecked; 27 persons injured.	Do.
Meeker to Davenport, Okla	28	4:30 p. m.	2 mi		20,000	Hail	Considerable damage	Do.
Dearing (near), Kans	28	6–8 p. m.				do	Many wheat and oat fields devastated; roofs damaged and window panes broken.	Do.
Washington County, Ark	28	6:30 p. m.				Tornado	Heaviest damage at Farmington; 7 houses demolished and orchards badly damaged.	Do.
Do	28	P. m.			100,000	Hail and rain	Orchards, vineyards, and strawberries damaged. Storm followed tornado of same date.	Do.
Provo Bench, Utah County, Utah.	29	7–7:10	2 mi		5,000	Moderate hail	Fruit and garden plants injured	Do.
Marinette, Ariz	30	6–7:30 a. m. or p. m.				Heavy hail	1,000 acres of cotton damaged 25 per cent. Store unroofed by wind.	Do.

STORMS AND WEATHER WARNINGS

By EDWARD H. BOWIE, Supervising Forecaster

WASHINGTON FORECAST DISTRICT

The month as a whole may be characterized as a quiet one, there being few storms of consequence, and in all cases the warnings were confined to the middle and north Atlantic coasts.

The first display was made on the evening of the 3d, when southeast warnings were ordered from Sandy Hook to Eastport, in connection with a disturbance over eastern Ontario. Warnings were again disseminated on the evening of the 7th, from the Virginia Capes to Boston, due to the northward movement of a secondary that developed over the south Atlantic States. The storm continued its slow northward movement and warnings of strong winds, thick weather, and rains were issued on the evening of the 9th from Sandy Hook to Portland. Another secondary that developed over the south Atlantic coast and moved to southeastern Virginia required the issuance of northeast warnings from Delaware Breakwater to Eastport. The necessity for warnings did not occur again until the 18th, when a disturbance of marked intensity was central southeast of Hudson Bay. Southwest warnings were ordered on the morning of that day for the Atlantic coast from Delaware Breakwater to Eastport. Southwest storm warnings were again displayed on the morning of the 24th from the Virginia Capes to Eastport. Small-craft warnings were displayed at Mobile and Pensacola during the 26th.

Warnings of light frosts were required on a number of days for portions of the Ohio Valley, the lower Lake region, and the north and middle Atlantic States.

CHICAGO FORECAST DISTRICT

From the point of view of the forecaster, May, 1924, in the Chicago Forecast District was a month of decided activity. Frost warnings were issued for some part of the district on every day but the 16th, and likewise frost occurred in some part of the district every night except that of the 16–17th. Furthermore, the month was much stormier than usual on the Great Lakes, winds of storm force or within four miles thereof having occurred at some one or more Lake stations on 20 days.

Frost warnings.—At the opening of the month the growth of vegetation had advanced sufficiently to be injured by frost northward across Nebraska, Iowa, southern Wisconsin, and Indiana. During the following two weeks the susceptible stage was reached over most of the remainder of the district, except the northern Lake region where frost warnings were not needed until about the close of the month. The dates on which the most general frost warnings were issued include the 6th to 10th, inclusive, 13th, 14th, 18th to 21st, inclusive, 23d to 25th, inclusive, and the 29th and 30th. The most damaging frost effects appear to have been those of the 11th in portions of Iowa, of the 19th and 20th in lower Michigan, and on several dates during the week ending on the 26th in North Dakota, Iowa, lower Michigan, and Indiana. Frosts were numerous in the Wisconsin cranberry bogs, and one observer described the month as a "terrible one."

Storm warnings.—There were three principal storm periods on the Great Lakes, namely, those of the 5–9th, 17–19th, and 23d–24th, all dates, inclusive. Altogether storm warnings were issued on nine days, and small-craft warnings on six additional days.

The first storm warning of the month was issued at 1 p. m. of the 5th for Lake Superior west of Marquette, northeast warnings being ordered. Noon special observations on that date had shown a disturbance of increasing intensity centered over the northern Plains, the lowest pressure being 29.48 inches. At the same time a high pressure area appeared in northern Manitoba, where the barometer read 30.24 inches. At 10 p. m. of the same date these warnings were extended over the Escanaba and Green Bay districts of Lake Michigan. By the morning of the 6th the disturbance was centered over Iowa with somewhat decreased energy, but verifying wind velocities had occurred during the night over most of the region where the warnings were displayed. Accordingly, small craft-warnings were issued for the remainder of the Great Lakes, and later, at 1 p. m., the warnings were continued on that portion of Lake Superior where already displayed. However, the latter were lowered at 10 p. m. As the disturbance moved slowly eastward it increased in intensity, so that it was necessary to issue northeast warnings on the night of the 7th for the northern portion of the Alpena District of Lake Huron. By the following morning the storm had still further increased in energy, and in connection with a high pressure area over Ontario had created a strong gradient across most of the Lake Region. As a result strong winds or moderate gales had set in over Lake Superior and the northern portions of Lakes Michigan and Huron. Therefore, the northeast warnings were extended over the remainder of the Great Lakes.

Twenty-four hours later, or on the morning of the 9th, a redevelopment of the storm had occurred over the Middle Mississippi Valley, and it was thus necessary to continue the warnings on Lakes Superior and Ontario, and on the northern portions of Lakes Michigan and Huron. At the same time small-craft warnings were displayed on Lake Erie. The warnings were lowered at 1 p. m. on Lake Ontario and at 9 p. m. elsewhere, as the storm lost energy rapidly after the morning of the 9th.

On the night of the 11th an advisory message was sent to all Lower Lakes stations relative to a disturbance then centered in southeastern Virginia and moving due north. By the following morning the center was near the District of Columbia, and the wind had reached moderate gale force at Cleveland, Ohio. Therefore, northeast warnings were issued for the Lower Lakes, except that the direction was made northwest west of Cleveland. The warnings were lowered at 9.30 p. m., the regular p. m. reports having showed that the storm was losing its force.

A northwest storm warning for Duluth, Minn., only, was issued at 2 p. m. of the 11th, the special observations indicating a disturbance over eastern Minnesota and a sharp gradient to the westward, with strong winds over North Dakota. It was necessary to continue this warning 24 hours later, owing to the fact that the disturbance had remained almost stationary during the 24 hours in question; at the same time the warnings were extended along the east shore of Lake Michigan. All warnings were lowered at 9:30 p. m., however, when it had become evident that the disturbance was losing energy.

On the morning of the 17th a rather deep low pressure area appeared north of Lake Superior, the lowest barometer being 29.32 inches. Thence southward to the Ohio River the gradient was marked. Accordingly, small-craft warnings were issued for Lakes Huron, Erie, and Ontario, but as developments showed, it would have been better to have displayed storm warnings. At points on Lakes Erie and Ontario verifying velocities were slightly exceeded. The disturbance was sluggish in its eastward progress, and small-craft warnings were again ordered on the morning of the 18th for the Lower Lakes, also for Lakes Superior and Huron. On this date moderate gales, and in some cases verifying velocities, occurred over portions of the Lakes in question.

The storm of the 23d–24th followed as a result of a general fall in pressure over the West during the two preceding days. On the morning of the 23d the disturbance existed as a trough extending from Lake Superior southwestward to Arizona, with the lowest pressure in southeastern Nebraska. At that time northwest warnings were issued for Lake Superior, and southwest warnings for Lakes Michigan, Huron, and Erie. In the afternoon the southwest warnings were extended over Lake Ontario. The disturbance moved northeastward with about normal velocity, but with an increase in energy. For the most part, the warnings issued in this connection were verified. On the night of the 23d the direction was changed to northwest on Lake Michigan, and likewise on Lakes Huron, Erie, and Ontario the following morning. Also, the northwest warnings were continued on Lake Superior east of Munising on the morning of the 24th. At 1 p. m. the warnings were lowered on Lake Michigan, southern Lake Huron, and Lake Erie west of Dunkirk, and at 9 p. m on Lake Ontario, northern Lake Huron, and Lake Erie, from Dunkirk, N. Y., east. A redevelopment of this storm occurred on the night of the 24th–25th in the vicinity of Lake Superior, with the result that it was necessary to issue northwest warnings on the morning of the 25th for that Lake from Munising west, and also for northern Lake Huron, as well as to continue the warnings on Lake Superior east of Munising. At the same time small craft warnings were issued for northeastern Lake Michigan, southern Lake Huron, and the Lower Lakes. At 9.30 p. m. the storm warnings were lowered. At Duluth, Minn., the wind reached a maximum velocity of 42 miles an hour on the 25th, and Alpena reported a maximum of 36 miles an hour on the following day.

Near the close of the month a disturbance from the Southwest threatened the southern Lake Region, especially the Lower Lakes, but it passed without causing winds of storm force. The only warning issued in this connection was that for small craft at Chicago.

The long range forecasts for the benefit of fruit interests in Door County, Wisconsin, were resumed during the month, and a similar service was begun for southwestern Michigan. Also, fire-weather forecasts were made for western Montana, the information being furnished to six Forest Supervisors.—*C. A. Donnel.*

NEW ORLEANS FORECAST DISTRICT

Small-craft warnings were displayed on the Texas Coast on the 6, 9, 10, 11, 15, 24, 26, and 28, and on the Louisiana Coast on the 29 and 30, for local thunder squalls. No general storm occurred on the Coast. Warnings for local thunderstorms were issued for Arkansas, Oklahoma, and eastern Texas on the 6; for Louisiana, Arkansas, and eastern Texas on the 27; Louisiana and East Texas on the 28; and Louisiana, eastern Texas and eastern Arkansas on the 29. Local thunderstorms occurred in the sev- States as forecast, and in a few localities the storms were severe.

Frost warnings were issued for the Texas Panhandle on the 7th, and for northern Oklahoma on the 15th.—*I. M. Cline.*

DENVER FORECAST DISTRICT

Low pressures prevailed on the Rocky Mountain Plateau during most of the period from the 1st to the 27th, with generally high pressures on the eastern slope and in the Plains States from the 6th to the 24th. There was little precipitation during the first two decades, and such occasional light showers as did occur were confined mostly to Colorado and extreme eastern New Mexico.

A LOW of considerable intensity that advanced from British Columbia to western Texas on the 24th, 25th, and 26th, together with a depression that remained over the extreme Southwest until the end of the month and a HIGH that prevailed in the Northern Rocky Mountain States and the upper Missouri Valley after the 26th, was attended by showers in Colorado and Utah and occasionally in northern New Mexico from the 25th to the 30th, with snow in the mountains of Colorado. Heavy showers fell in Colorado and eastern and northern Utah from the 27th to the 29th and in northern New Mexico on the 30th. The temperature was much below normal in Colorado and Utah from the 26th to the 31st.

Frost warnings were issued as follows: 1st, frost in Colorado, extreme northern New Mexico, and the higher elevations of southern Utah; 5th, frost in the western valleys of Colorado, northern New Mexico, heavy frost in Utah, and freezing temperature at the higher elevations of southern Utah; 6th, heavy frost in Colorado and Utah, frost in northern New Mexico, freezing temperature at the higher elevations of Utah; 7th, frost in Colorado, northern New Mexico, and Utah; 8th, frost or freezing temperature in southwestern Colorado and frost in extreme northern New Mexico; 9th, frost or freezing

temperature in eastern and southern Colorado and frost in extreme northern New Mexico; 10th, frost in eastern Colorado and extreme northern New Mexico; 12th, frost in eastern Colorado; 13th, frost in northeastern Colorado; 14th, frost in southern and eastern Colorado and extreme northern New Mexico; 15th, frost in southern and extreme eastern Colorado and extreme northern New Mexico; 19th, frost in eastern Colorado; 24th, probably frost in northeastern Colorado; 29th, frost in northwestern Utah; 30th, frost in Colorado, if sky clears; 31st, frost in northern and western Colorado and southeastern Utah.

These warnings were generally verified by the occurrence of frost or by the ensuing temperature conditions.

No other warnings were issued or required during the month.—*J. M. Sherier*.

SAN FRANCISCO FORECAST DISTRICT

A moderate storm moved southward over the Rocky Mountain region during the first few days of the month and gave light but general rain in the north Pacific States on the 4th, but with this exception only a few scattered showers occurred in this district.

After the first few days the weather became very warm in all portions of this district and continued so throughout the month. This, in conjunction with the prevailing drought caused a condition that was extremely favorable for forest and grain fires, and fire-weather warnings were issued as follows: In northern California on the 5th, and thereafter precautionary warnings were broadcast by radio. On the 22d special daily warnings were commenced to Forest Service stations in Idaho.

It is pleasing to note in connection with the distribution of these warnings that the General Electric Co. in Oakland, Calif., and the Examiner in San Francisco, Calif., are cooperating with this office by broadcasting all warnings by radio, the General Electric broadcasting about noon and the Examiner about 7 p. m.—*G. H. Willson*.

RIVERS AND FLOODS

By H. C. FRANKENFIELD, Meteorologist

Rains were frequent and occasionally heavy during the month of May over the territory east of the Mississippi River, and as a result floods were numerous, although not of serious character, except over the drainage area of the Potomac River. The floods were most prevalent during the second decade of the month and details regarding all will be found in the table at the end of this report. Lack of space forbids a more extended report.

The Potomac flood occurred from May 12 to 15, and was most severe in the Shenandoah River and in the Potomac from Harpers Ferry, W. Va., to Washington, D. C. Above Harpers Ferry the flood proportions were much less than in March, 1924, although the streets of Cumberland, Md., were again covered with water, with resulting damage of about $35,000. From Harpers Ferry to Washington and in the Shenandoah River the flood was the severest since the memorable flood of June 1 and 2, 1889, and the damage amounted to about $1,000,000.

The principal street of Harpers Ferry was under water to a depth of 6 feet at the lowest place, and just above Washington the banks of the Chesapeake & Ohio Canal were washed out for a considerable distance.

When the large area covered by the flood waters is considered, it will be seen that the losses were relatively small. In South Carolina the rivers had been above the flood stage for so long that livestock could not graze in the lowlands, and but little planting had been done. Elsewhere the most serious aspect was the delay in farming operations.

The flood in the Arkansas River began about April 29 in the vicinity of Wichita, Kans., and extended only to a short distance below Fort Smith, Ark.

Floods in the rivers of Texas and in the Colorado River of Arizona were moderate. Along the Rio Grande in the State of New Mexico conditions were more critical, but fortunately the flood waters passed off without damage of consequence.

As the deficiency in snowfall during the last winter had indicated, the annual rise in the Columbia was very moderate, with no flood stages except at a very few points. Even at these the crest stages were only slightly above the flood stage.

Losses for the month as reported aggregated $1,118,500, of which about $1,000,000 occurred in the Potomac River drainage area. Direct crop losses were not large (only $36,000 reported) but the indirect losses due to delayed farm operations must have been very heavy. About 4,000 acres of farm lands were submerged in the Evansville, Ind., district, 3,000 acres in the Fort Smith, Ark., district, and about 500 acres along the upper Trinity River of Texas.

The value of property saved through the Weather Bureau warnings was $121,800, not including an estimate of several hundred thousand dollars in Pittsburgh, Pa.

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ATLANTIC DRAINAGE					
	Feet			*Feet*	
Connecticut:					
White River Junction, Vt	15	2	6	16.9	2
Potomac:					
Cumberland, Md	8	12	12	13.8	12
Harpers Ferry, W. Va	18	9	9	19.0	9
		12	14	27.6	13
Washington, D. C	8	13	14	12.1	14
Shenandoah:					
Riverton, Va	22	12	13	34.0	12
James:					
Buchanan, Va	15	12	13	19.1	13
Columbia, Va	18	12	14	31.5	12
Richmond, Va	10	13	15	21.0	14
Roanoke:					
Randolph, Va	21	12	13	21.7	13
Weldon, N. C	30	13	15	38.4	13
		22	23	32.5	22
Tar:					
Rocky Mount, N. C	9	16	16	9.0	16
Tarboro, N. C	18	18	18	18.0	18
Greenville, N. C	14	19	20	14.2	20
Neuse:					
Neuse, N. C	15	14	15	15.4	14
Smithfield, N. C	14	16	17	14.5	16
Santee:					
Rimini, S. C	12	1	11	13.4	4-5
		17	18	12.3	18
		30	31	12.3	31
Ferguson, S. C	12	[1]	12	13.2	6
		18	19	12.1	18
Saluda:					
Pelzer, S. C	7	[1]	[2]	7.0	Apr. 30
Chappells, S. C	14	2	2	14.4	2
EAST GULF DRAINAGE					
Coosa:					
Lock No. 4, Lincoln, Ala	17	28	29	18.0	28
Black Warrior:					
Lock No. 10, Tuscaloosa, Ala	46	29	30	50.7	29
Pearl:					
Jackson, Miss	20	[1]	[2]		
MISSISSIPPI DRAINAGE					
Stony Creek:					
Johnstown, Pa	10	9	9	11.0	9
		12	12	13.5	12
Kiskiminetas:					
Saltsburg, Pa	8	9	9	8.0	9
		12	13	11.0	12

[1] Continued from last month.
[2] Below flood stage 8 a. m. May 1.

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
MISSISSIPPI DRAINAGE—continued	Feet			Feet	
Monongahela:					
Lock No. 15, Hoult, W. Va	22	12	13	27.8	12
Lock No. 10, Morgantown, W. Va	25	12	13	27.7	12
Lock No. 7, Martin, Pa	30	12	13	38.6	12
Lock No. 4, Pa	31	12	14	40.8	13
Cheat:					
Rowlesburg, W. Va	12	12	12	12.3	12
Youghiogheny:					
Confluence, Pa	10	12	12	11.8	12
Ohio:					
Pittsburgh, Pa	22	13	14	26.4	13
Lock No. 2, Coraopolis, Pa	26	13	13	26.0	13
Dam No. 6, Beaver, Pa	30	13	14	35.5	13
Marietta, Ohio	33	14	16	35.8	15
Parkersburg, W. Va	36	15	16	37.4	15
Dam No. 22, Ravenswood, W. Va	42	15	15	42.0	15
Point Pleasant, W. Va	40	14	17	45.4	15
Dam No. 29, Normal, Ky	50	15	17	51.2	16
Evansville, Ind	35	20	24	36.5	22
Henderson, Ky	33	21	24	33.9	22–23
Dam No. 48, Cypress, Ind	42	22	23	42.4	22
Muskingum:					
Marietta, Ohio	36	15	15	37.4	15
Tuscarawas:					
Gnadenhutten, Ohio	10	15	16	10.8	16
Little Kanawha:					
Glenville, W. Va	23	12	13	29.7	13
Creston, W. Va	20	13	13	23.4	13
Kanawha:					
Charleston, W. Va	30	13	13	30.0	13
Elk:					
Clay, W. Va	18	12	13	23.6	12
White, West Fork:					
Edwardsport, Ind	14	(1)	2	16.1	Apr. 30
Illinois:					
Henry, Ill	7	(1)	20	13.5	Apr. 5
Beardstown, Ill	12	(1)	12	17.6	Apr. 9
Meramec:					
Pacific, Mo	11	29	(2)	17.5	31
Valley Park, Mo	14	29	(2)	19.5	31
Bourbeuse:					
Union, Mo	10	29	(2)	14.1	31
Arkansas:					
Wichita, Kans	9	(1)	1	10.8	Apr. 30
Fort Smith, Ark	22	1	3	23.0	2
Dandanelle, Ark	20	1	4	21.2	3
Little Arkansas:					
Sedgwick, Kans	18	(1)	(3)	------	------
Petit Jean:					
Danville, Ark	20	(1)	4	24.7	1
Black:					
Black Rock, Ark	14	1	1	14.0	1
Cache:					
Patterson, Ark	9	7	9	9.2	8–9
Sulphur:					
Ringo Crossing, Tex	20	27	(2)	25.1	30–31
North Platte:					
North Platte, Nebr	5	7	11	5.3	10
Osage:					
Warsaw, Mo	22	31	31	22.7	31
WEST GULF DRAINAGE					
Trinity:					
Dallas, Tex	25	(1)	(3)	------	------
	------	27	29	31.0	28
Trinidad, Tex	28	3	5	29.4	4
Liberty, Tex	25	1	6	26.6	3–4
Guadalupe:					
Victoria, Tex	16	18	18	17.1	18
Rio Grande:					
Albuquerque, N. Mex	4	13	14	4.0	13–14
San Marcial, N. Mex	2	(1)	(2)	4.8	17–18
COLORADO DRAINAGE					
Colorado:					
Lees Ferry, Ariz	12	7	(2)	14.4	23–24
Parker, Ariz	7	(1)	1	7.0	1
	------	11	(2)	8.9	26–27
PACIFIC DRAINAGE					
Columbia:					
Marcus, Wash	24	20	(2)	26.7	27–28
Vancouver, Wash	15	24	30	15.3	28–29
Clearwater:					
Kamiah, Idaho	14	13	14	14.1	13

[1] Continued from last month.
[2] Continued at end of month.
[3] Below flood stage at 8 a. m., May 1.

MEAN LAKE LEVELS DURING MAY, 1924

By UNITED STATES LAKE SURVEY

[Detroit, Mich., June 5, 1924]

The following data are reported in the "Notice to Mariners" of the above date:

Data	Lakes [1]			
	Superior	Michigan and Huron	Erie	Ontario
Mean level during May, 1924:	Feet	Feet	Feet	Feet
Above mean sea level at New York	601.19	579.24	572.16	246.10
Above or below—				
Mean stage of April, 1924	+0.17	+0.37	+0.39	+0.74
Mean stage of May, 1923	−0.38	−0.38	+0.34	+0.48
Average stage for May last 10 years	−0.90	−1.35	−0.46	−0.36
Highest recorded May stage	−1.86	−4.28	−2.26	−2.85
Lowest recorded May stage	+0.37	−0.32	+0.85	+1.14
Average relation of the May level to—				
April level		+0.3	+0.4	+0.3
June level		−0.2	−0.2	−0.2

[1] Lake St. Clair's level: In May, 1924, 574.56 feet.

EFFECT OF THE WEATHER ON CROPS AND FARMING OPERATIONS. MAY—1924

By J. B. KINCER

The month of May was decidedly unfavorable for agricultural interests in much the greater portion of the country, except that grass and winter grains made rather satisfactory progress in most districts. The weather was persistently cool in nearly all sections east of the Rocky Mountains, and there was too much rain in many localities, especially in parts of the South, and generally from the Ohio Valley northward and eastward. West of the Rocky Mountains severe drought and unseasonably warm weather obtained, which was very detrimental to all dry-land crops, especially to the small grains. Irrigated crops made good progress, but at the same time there was a heavy drain on the water supply, which was becoming short in many sections.

Corn planting was very greatly delayed by the cool weather and frequent showers in central districts east of the Mississippi River. Much corn remained to be planted in the Ohio Valley and Middle Atlantic States at the close of the month, some States reporting that only about half of the crop had been put in. Germination was also unsatisfactory, necessitating much replanting. Between the Mississippi River and Rocky Mountains the drier weather permitted better progress in planting, but it continued too cool for germination and growth in most sections. Corn came up to a fairly good stand in Missouri but was off color, and the general condition in Iowa at the close of the month was very poor.

Winter grains made fairly good growth in most of the principal producing areas, under the influence of the cool, moist weather. During the middle portions of the month moisture was deficient in the western winter-wheat belt, especially in Kansas where some deterioration of the crop was reported. Good rains fell the latter part of the month, however, in this area, which materially

improved conditions. West of the Rocky Mountains, the lack of moisture seriously damaged winter wheat. The growth of spring wheat was slow because of cool weather, but the general condition of this crop was satisfactory at the close of the month, and it was stooling well. There was some damage to flax by frost in the northern Plains States, but the harm was not material, and the crop had come up to a good stand. Oats were generally late and unfavorable affected by the weather in some of the heavy producing areas, with seeding very backward from the Lake region eastward.

Rainfall was rather unevenly distributed in the Cotton Belt, with too much moisture in some portions. It was too wet in the northern portion of the belt the latter part of the month, and the weather was persistently cool. These conditions were decidedly unfavorable for cotton, although the somewhat warmer weather, especially the warmer nights, was more favorable in the southern portion. Early-planted cotton deteriorated in Texas, though the crop made very good progress in central and southern portions during part of the month. Stands were irregular and growth slow in Oklahoma, and the plants were very uneven in Arkansas.

The warmer weather the latter part of the month was rather favorable in Louisiana, though the crop was generally backward and the stands poor in the northern portion of the State. Growth was slow in Mississippi, and poor to only fair in Alabama. In southern Georgia sufficient dry weather permitted cultivation in the southern portion of the State where the stands were very good, but it was too wet and cold in the northern portion. The cool, wet weather was very unfavorable in the more northeastern portions of the belt, and stands were only fair in South Carolina where considerable replanting was necessary.

Truck and garden crops were very backward in all central and eastern portions of the country, but grass made fairly good progress by reason of generally ample rainfall. West of the Rocky Mountains the lack of moisture was unfavorable for range land and pastures were poor. Rains benefited ranges the latter part of the month in the central Rocky Mountain area.

The condition of fruit remained generally satisfactory east of the Rocky Mountains, though there was some frost damage in the Lake region. Late estimates from portions of the far Northwest, especially eastern Washington, indicated much greater damage to fruit from the previous freezes than had been thought. There was almost a total loss of peaches and apricots in the Walla Walla district, and serious reduction to other fruits in that section.

CLIMATOLOGICAL TABLES[1]

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, May, 1924

Section	Temperature								Precipitation					
	Section average	Departure from the normal	Monthly extremes						Section average	Departure from the normal	Greatest monthly		Least monthly	
			Station	Highest	Date	Station	Lowest	Date			Station	Amount	Station	Amount
	° F.	° F.		° F.			° F.		In.	In.		In.		In.
Alabama	67.9	−3.8	Talladega	94	28	2 stations	36	[2] 8	4.22	+0.24	Winfield	8.79	Cochrane	0.87
Alaska														
Arizona	68.6	+2.9	Quartzsite	114	16	Williams	25	14	0.09	−0.23	Blue	0.73	25 stations	0.00
Arkansas	64.6	−4.6	2 stations	94	[2] 18	2 stations	30	11	4.64	−0.48	Jonesboro	7.86	Little Rock	2.44
California	65.2	+3.8	Greenland Ranch	113	17	Portola	19	3	0.08	−1.01	Crescent City	1.59	91 stations	0.00
Colorado	49.8	−2.5	Lamar	93	17	Corona	0	6	1.99	+0.23	Long's Peak	6.09	2 stations	T.
Florida	75.0	−0.7	New Smyrna	103	28	Quincy	43	12	3.06	−1.32	Allapattah	12.85	Melrose	0.04
Georgia	69.0	−3.0	Saint George	98	29	2 stations	34	[2] 9	3.73	+0.34	Marietta	7.72	Savannah	1.49
Hawaii	71.9	+0.3	2 stations	91	[2] 21	Waimea	46	30	4.80	−1.73	Eke	33.50	5 stations	0.00
Idaho	57.3	+5.1	Chattin's Flat	102	25	Stanley	10	6	0.26	−1.47	Eik City	1.42	4 stations	0.00
Illinois	56.9	−5.8	Mount Carmel	91	5	Waukegan	28	1	3.53	−0.70	Effingham	7.09	Walnut	1.26
Indiana	56.0	−6.3	Laporte	92	7	Goshen	27	22	4.13	+0.01	Rockville	6.13	Greensburg	2.52
Iowa	54.1	−6.4	3 stations	95	5	Inwood	26	24	1.71	−2.86	Nora Springs	3.28	Alton	0.78
Kansas	58.1	−5.2	2 stations	95	17	4 stations	26	10	2.12	−1.71	Pittsburg	8.08	Greensburg	0.59
Kentucky	59.9	−5.7	Bowling Green	92	5	Farmers	34	26	5.04	+1.07	Glasgow	8.37	Falmouth	2.30
Louisiana	70.9	−2.9	Dodson	95	[2] 27	Minden	40	11	4.78	+0.45	Logansport	10.98	Clinton	1.00
Maryland-Delaware	58.8	−4.1	Frederick, Md	94	6	Grantsville, Md	26	5	6.44	+2.86	Frostburg, Md	8.68	Delaware City, Del	4.43
Michigan	48.2	−5.4	Sturgis	84	6	Sidnaw	10	5	3.64	+0.38	Old Mission	6.82	Eagle Harbor	0.73
Minnesota	47.7	−7.0	Pipestone	94	5	2 stations	17	[2] 3	1.86	−1.53	New Ulm	3.43	Hallock	0.65
Mississippi	68.4	−3.5	2 stations	95	[2] 28	Pontotoc	38	11	4.52	−0.12	Pontotoc	10.93	Magnolia	0.82
Missouri	58.6	−6.0	Caruthersville	96	6	Hollister	31	15	4.67	−0.03	Lamar	7.61	Tarkio	1.55
Montana	52.4	+0.8	2 stations	93	[2] 15	3 stations	17	6	0.84	−1.44	Adel	2.63	Kippen	0.10
Nebraska	53.6	−5.4	Curtis	99	5	Harrison	19	13	1.90	−1.68	Upland	5.10	Valentine	0.56
Nevada	62.0	+6.1	Logandale	105	17	Rye Patch	11	5	0.05	−0.83	Arthur	0.49	14 stations	0.00
New England	51.7	−3.0	Waterbury, Conn	81	26	4 stations	22	[2] 2	3.72	+0.48	Somerset, Vt	6.55	Bethlehem, N. H	1.71
New Jersey	56.8	−3.7	3 stations	87	6	Charlotteburg	25	5	5.69	+1.96	Little Falls	7.94	Atlantic City	3.36
New Mexico	59.3	−0.4	Gage	100	19	Luna	14	2	0.65	−0.37	Trementina	3.24	8 stations	0.00
New York	51.1	−5.0	Jamestown	84	7	Indian Lake	18	3	4.55	+0.87	Taberg	8.45	Chazy	2.30
North Carolina	63.9	−2.6	3 stations	94	[2] 21	Mount Mitchell	24	[2] 9	5.27	+1.19	Nashville	10.53	Hiddenite	1.72
North Dakota	46.9	−5.7	Pembina	84	15	2 stations	15	[2] 5	0.79	−1.76	Mayville	3.32	Dunseith	0.02
Ohio	54.6	−6.2	Clarington	94	7	2 stations	27	22	4.10	+0.43	Wilmington	6.80	Catawba Island	1.57
Oklahoma	63.8	−3.9	Mangum	102	19	3 stations	28	[2] 10	2.44	−2.40	Broken Bow	7.47	Hollis	0.38
Oregon	59.0	+5.3	Blitzen	108	16	Fremont	9	5	0.31	−1.51	Mapleton	1.44	8 stations	0.00
Pennsylvania	54.6	−5.0	2 stations	92	6	Muncy Valley	18	2	5.71	+1.87	Cresson	9.64	Wellsboro	3.31
Porto Rico	77.8	+0.6	2 stations	98	[2] 14	2 stations	57	[2] 11	3.88	−3.11	Coloso	11.91	Ponce	0.35
South Carolina	68.0	−3.1	Summerville	96	21	Landrum	33	11	4.43	+0.75	Florence No. 2	7.61	Paris Island	1.96
South Dakota	50.8	−5.1	3 stations	95	5	2 stations	18	24	0.86	−2.17	La Delle	2.86	McIntosh	T.
Tennessee	61.8	−5.3	Johnsonville	92	20	3 stations	33	[2] 11	5.75	+1.67	Waynesboro	8.60	Jefferson City	3.68
Texas	70.0	−3.0	4 stations	105	[2] 26	Lieb (near)	33	15	4.35	+0.67	Conroe	16.51	El Paso	T.
Utah	58.1	+3.2	Saint George	100	17	Woodruff	10	6	0.97	−0.27	Santaquin	2.74	Emery	0.00
Virginia	60.5	−4.1	Saltville	95	6	Burkes Garden	26	2	7.19	+3.58	Newport News	11.79	Quantico	2.64
Washington	59.2	+4.8	2 stations	100	11	Paradise Inn	15	6	0.28	−1.62	Quinault	2.51	12 stations	0.00
West Virginia	55.5	−6.3	Wheeling	93	7	Cheat Bridge	23	10	7.20	+3.21	Burlington	12.20	Bluefield	3.91
Wisconsin	48.5	−6.2	Prairie du Chien	88	5	Long Lake	12	2	3.38	−0.58	Shawano	6.86	Downing	0.92
Wyoming	48.1	−0.8	3 stations	86	[2] 3	Foxpark	0	28	1.67	−0.51	Middle Fork (near)	6.32	Lovell	T.

[1] For description of tables and charts, see REVIEW, January, 1924, pp. 56-57.

[2] Other dates also.

TABLE I.—*Climatological data for Weather Bureau stations, May, 1924*

Districts and stations	Elevation of instruments: Barometer above sea level	Thermometer above ground	Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Sea level, reduced to mean of 24 hours	Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Departure from normal	Maximum	Date	Mean maximum	Minimum	Date	Mean minimum	Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Departure from normal	Days with 0.01, or more	Wind: Total movement	Prevailing direction	Maximum velocity: Miles per hour	Direction	Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	In.	In.		Miles								0–10	In.	In.
New England							**52.4**	**−2.1**										**76**	**3.22**	**−0.1**										**6.2**		
Eastport	76	67	85	29.76	29.84	−.12	46.6	−1.1	66	27	54	36	10	40	24	43	39	75	1.83	−2.0	10	8,767	s.	48	se.	1	6	7	18	7.1	0.0	0.0
Greenville, Me.	1,070	6		28.66	29.82		47.2		74	18	56	25	3	38	32				4.52		12		se.				8	5	18		T.	0.0
Portland, Me.	103	82	117	29.74	29.87	−.10	51.6	−1.7	73	17	59	38	3	44	31	45	40	69	4.27	+0.6	14	7,906	s.	46	se.	1	9	8	14	6.2	0.0	0.0
Concord	288	70	79	29.53	29.84	−.14	52.4	−1.9	75	24	62	33	3	42	36				2.35	−0.9	14	5,375	w.	33	s.	24	9	12	10	5.7	0.0	0.0
Burlington	404	11	48	29.38	29.82	−.15	50.4	−3.5	75	18	58	32	3	42	28				2.60	−0.2	13	8,386	s.	50	s.	18	2	10	19	7.4	T.	0.0
Northfield	876	12	60	28.89	29.84	−.13	48.8	−4.7	74	18	59	25	3	39	41	46	41	75	2.78	0.0	15	6,474	s.	42	sw.	18	2	12	17	7.3	T.	0.0
Boston	125	115	188	29.72	29.86	−.12	56.2	−0.9	76	17	64	42	11	49	25	50	46	74	2.81	−0.7	11	8,124	w.	39	sw	24	6	13	12	6.5	0.0	0.0
Nantucket	12	14	90	29.85	29.86	−.13	51.8	−1.2	67	29	57	42	3	46	19	49	47	86	4.07	+1.4	13	12,704	sw.	48	se.	1	9	11	11	5.5	0.0	0.0
Block Island	26	11	46	29.83	29.86	−.13	51.7	−1.1	66	29	56	42	11	47	16	49	48	90	2.73	−1.0	16	12,928	sw.	48	ne.	12	10	11	10	5.3	0.0	0.0
Providence	160	215	251	29.70	29.87	−.11	55.4	−3.1	75	17	64	40	9	47	25	49	43	69	2.71	−0.8	18	9,907	w.	47	w.	24	8	12	11	6.0	0.0	0.0
Hartford	159	122	140	29.70	29.87	−.11	55.6	−1.9	74	28	64	41	2	47	27				3.70	+0.2	18		sw.				12	5	14	5.8	0.0	0.0
New Haven	106	74	153	29.74	29.86	−.11	56.2	−1.7	74	17	64	43	2	49	24	50	45	72	5.57	+1.9	18	7,842	ne.	37	sw.	24	10	9	12	5.7	0.0	0.0
Middle Atlantic States							**58.3**	**−3.6**										**73**	**5.23**	**+1.7**										**5.9**		
Albany	97	102	115	29.74	29.84	−.14	54.5	−4.8	75	17	63	37	3	46	33	49	44	71	2.80	−0.2	17	5,732	s.	39	s.	24	7	10	14	6.4	0.0	0.0
Binghamton	871	10	84	28.87	29.80	−.18	52.7	−4.3	80	7	62	34	5	44	38				3.50	+0.4	17	5,069	w.	32	sw.	18	2	9	20	7.9	0.0	0.0
New York	314	414	454	29.52	29.85	−.14	56.2	−4.4	71	24	63	44	11	50	20	51	45	70	5.23	+2.0	14	13,482	e.	54	nw.	30	6	11	14	6.7	0.0	0.0
Harrisburg	374	94	104	29.46	29.86	−.12	57.7	−4.1	87	6	66	42	5	50	34	51	45	66	6.49	+2.8	15	5,422	w.	37	sw.	18	6	9	16	6.8	0.0	0.0
Philadelphia	114	123	190	29.74	29.87	−.12	59.2	−3.7	84	6	67	45	10	52	31	52	46	67	4.91	+1.7	16	7,829	w.	39	sw.	18	8	9	14	6.2	0.0	0.0
Reading	325	81	98	29.51	29.86		57.2		86	6	66	41	5	49	31	54	52	82	5.36	+2.0	14	5,420	nw.	25	nw.	18	9	10	12	5.9	0.0	0.0
Scranton	805	111	119	29.00	29.86	−.12	55.0	−3.8	81	7	64	36	5	46	31	52	50	86	3.91	+0.5	16	6,065	s.	38	sw.	18	3	15	13	7.0	0.0	0.0
Atlantic City	52	37	172	29.81	29.86	−.12	56.8	−1.3	75	28	62	46	5	51	22	52	48	75	3.36	+0.4	16	14,444	s.	50	e.	12	16	4	11	4.7	0.0	0.0
Cape May	18	13	49	29.88	29.90	−.09	58.5	−0.1	75	28	64	47	5	52	21	53	50	78	3.83	+0.8	17	7,410	s.	42	s.	24	11	7	13	5.5	0.0	0.0
Sandy Hook	22	10	55	29.83	29.85		56.4		72	17	62	45	10	50	21	51	46	74	4.77		14	12,037	w.	56	s.	24	6	11	14	6.1	0.0	0.0
Trenton	190	159	183	29.66	29.87		57.2		82	6	65	43	10	49	31	52	48	75	4.65	+1.1	15	9,816	w.	49	sw.	24	9	8	14	6.1	0.0	0.0
Baltimore	123	100	113	29.72	29.86	−.13	60.2	−4.2	85	6	68	45	5	52	31	54	49	69	5.80	+2.2	15	5,208	sw.	38	ne.	11	9	9	13	5.8	0.0	0.0
Washington	112	62	85	29.74	29.86	−.14	60.0	−3.7	88	6	69	40	5	51	36	53	48	67	6.73	+2.9	16	5,094	nw.	30	e.	11	8	9	14	6.0	0.0	0.0
Cape Henry	18	8	54	29.85	29.87		63.9		92	29	71	49	12	57	26	58	55	76	8.59	+4.6	16	9,491	sw.	44	n.	25	9	15	7	5.3	0.0	0.0
Lynchburg	681	153	188	29.12	29.86	−.14	61.4	−5.9	88	6	72	37	2	50	39	55	50	68	5.16	+1.2	14	5,971	w.	36	nw.	24	14	8	9	5.1	0.0	0.0
Norfolk	91	170	205	29.79	29.89	−.11	65.2	−1.0	89	29	74	50	12	56	32	58	53	71	7.47	+3.4	15	10,006	s.	50	w.	21	11	13	7	5.4	0.0	0.0
Richmond	144	11	52	29.72	29.87	−.12	62.8	−3.7	86	29	73	43	2	52	35	56	51	71	7.36	+3.5	16	6,199	s.	33	nw.	14	14	7	10	5.1	0.0	0.0
Wytheville	2,304	49	55	27.53	29.88	−.11	56.1	−5.3	84	6	67	35	2	45	37	50	46	71	3.73	−0.2	14	5,227	w.	33	w.	18	13	9	9	4.9	0.0	0.0
South Atlantic States							**68.3**	**−1.9**										**70**	**3.18**	**−0.6**										**4.7**		
Asheville	2,255	70	84	27.58	29.90	−.09	58.6	−4.0	86	20	70	38	17	48	35	51	46	68	3.07	−0.5	11	5,815	nw.	28	n.	12	13	9	9	4.5	0.0	0.0
Charlotte	779	55	62	29.06	29.89	−.10	66.0	−2.9	90	20	76	45	12	56	33	57	51	63	2.82	−1.1	8	3,143	sw.	24	w.	28	14	7	10	4.9	0.0	0.0
Hatteras	11	11	50	29.89	29.90	−.11	66.3	−2.4	78	6	73	52	23	60	21	62	59	78	4.95	+0.8	9	10,292	sw.	44	s.	27	11	12	8	4.5	0.0	0.0
Manteo	12	5	42				65.3		90	29		46	17		30				3.50		8		s				19	6	6		0.0	0.0
Raleigh	376	103	110	29.48	29.88	−.11	66.8	−1.7	89	29	77	46	12	57	33	59	53	67	5.16	+0.3	11	6,077	sw.	31	sw.	29	12	9	10	5.4	0.0	0.0
Wilmington	78	81	91	29.83	29.91	−.10	69.3	−1.5	88	29	78	47	12	61	25	62	59	74	5.02	+1.0	10	5,960	sw.	28	s.	11	13	14	4	4.2	0.0	0.0
Charleston	48	11	92	29.88	29.93	−.08	72.4	−0.3	92	30	80	53	12	65	26	65	61	72	2.38	−1.1	8	7,986	sw.	34	s.	11	11	10	10	5.2	0.0	0.0
Columbia, S. C.	351	41	57	29.54	29.91	−.09	69.6	−2.3	91	20	80	51	12	59	28	62	59	76	3.74	+0.6	10	4,872	sw.	30	w.	24	14	8	9	4.6	0.0	0.0
Due West	711	10	55	29.17	29.93		66.2		89	20	77	45	2	55	31				4.19		10	6,741	sw.	31	w.	8	9	12	10	5.3	0.0	0.0
Greenville, S. C.	1,039	113	122	28.80	29.88		65.2	−2.0	87	20	75	46	2	55	27	57	50	63	3.36		10	6,773	sw.	47	nw.	28	14	12	5	4.4	0.0	0.0
Augusta	180	62	77	29.72	29.91	−.08	70.0	−2.4	92	20	81	50	12	59	31	63	59	71	2.73	−0.5	11	4,419	nw.	37	sw.	28	14	11	6	4.3	0.0	0.0
Savannah	65	150	194	29.87	29.94	−.06	72.6	−0.8	93	30	82	52	12	64	25	64	59	67	1.49	−1.5	5	9,120	w.	36	sw.	27	10	14	7	4.4	0.0	0.0
Jacksonville	43	209	245	29.90	29.95	−.05	74.0	−1.0	93	29	83	54	12	66	23	65	60	68	0.49	−3.8	5	7,476	sw.	35	nw.	25	11	14	6	4.9	0.0	0.0
Florida Peninsula							**78.0**	**−0.1**										**75**	**5.03**	**+0.8**										**5.0**		
Key West	22	10	64	29.94	29.95	−.02	80.2	+1.1	90	31	86	68	5	74	18	73	71	75	2.12	−1.2	8	5,566	se.	50	w.	7	11	14	6	4.7	0.0	0.0
Miami	25	71	79	29.95	29.98		77.7	−0.9	92	22	85	64	13	71	21	71	69	76	7.45	+1.0	14	4,787	se.	23	w.	22	6	15	10	6.0	0.0	0.0
Sand Key	23	39	72	29.94	29.97	.00	78.4		86	31	81	68	4	75	13	73	71	78	2.27		5	6,477	se.	53	n.	18	13	13	5	4.4	0.0	0.0
Tampa	35	79	87	29.93	29.96	−0.3	76.0	−0.4	91	26	84	59	13	68	26	68	64	72	5.51	+2.6	5	4,071	w.	26	nw.	23	7	17	7	5.1	0.0	0.0
East Gulf States							**69.1**	**−3.3**										**70**	**3.37**	**−0.1**										**4.7**		
Atlanta	1,174	190	216	28.70	29.93	−.06	65.8	−4.1	86	29	74	44	16	57	24	58	53	66	3.60	+0.5	8	8,297	nw.	40	nw.	29	11	9	11	5.2	0.0	0.0
Macon	370	78	87	29.54	29.93	−.06	68.8	−3.5	92	29	80	47	17	58	32	60	54	62	2.62	−0.3	8	4,515	sw.	26	sw.	27	11	11	9	4.9	0.0	0.0
Thomasville	273	49	58	29.66	29.95	−.04	71.9	−2.1	92	29	82	50	12	62	30	63	58	67	2.14	−1.9	8	3,201	sw.	18	sw.	27	9	9	13	5.7	0.0	0.0
Apalachicola	36	42	49	29.92	29.96		71.6		87	30	78	54	12	65	23	66	63	77	1.80		5	5,081	sw.	21	sw.	15	16	11	4	3.8	0.0	0.0
Pensacola	56	149	185	29.90	29.96	−.03	71.0	−2.9	85	25	76	53	11	66	19	65	62	75	2.14	−0.5	8	9,272	sw.	37	sw.	27	12	10	9	5.0	0.0	0.0
Anniston	741	9	57	29.17	29.96	−.03	65.4	−3.0	89	29	77	40	9	53	36				3.78	+0.7	10	3,585	nw.	23	nw.	29	18	6	7	3.3	0.0	0.0
Birmingham	700	11	48	29.20	29.96	−.02	66.7	−4.4	89	28	78	43	9	56	29	58	53	66	3.44	+0.4	9	4,756	nw.	28	s.	27	14	9	8	4.4	0.0	0.0
Mobile	57	125	161	29.90	29.96	−.03	71.0	−2.9	87	28	79	51	12	63	23	65	62	77	4.10	+0.1	10	7,044	sw.	28	nw.	8	14	7	10	4.7	0.0	0.0
Montgomery	223	100	112	29.71	29.95	−.04	69.4	−4.0	91	29	79	49	9	60	29	61	56	67	4.40	+0.6	9	4,808	sw.	26	n.	24	13	10	8	5.1	0.0	0.0
Corinth	469	6					64.9		90	28	76	40	11	53	34				6.38		14		s.				6	22	3		0.0	0.0
Meridian	375	85	93	29.55	29.94	−.04	67.8	−3.5	90	28	78	45	12	58	31	61	56	70	1.33	−2.6	10	3,909	sw.	23	se.	26	15	7	9	4.8	0.0	0.0
Vicksburg	247	65	73	29.69	29.97	.00	68.2	−4.7	89	28	77	51	11	59	27	61	57	74	3.61	−0.6	14	4,564	sw.	38	ne.	20	15	5	11	4.8	0.0	0.0
New Orleans	53	76	84	29.90	29.95	−.02	74.2	−1.2	90	28	82	59	11	67	21	66	63	72	5.96	+2.1	9	4,583	sw.	27	sw.	21	14	9	8	4.5	0.0	0.0
West Gulf States							**69.1**	**−3.7**										**73**	**4.64**	**+0.6**										**5.2**		
Shreveport	249	77	93	29.68	29.94	−.01	68.6	−4.6	90	28	78	46	11	60	25	62	57	73	7.04	+2.9	12	5,087	s.	42	nw.	20	14	9	9	4.5	0.0	0.0
Bentonville	1,303	11	44				60.6	−5.8	85	19	71	39	10	50	31				2.78		9	3,374	nw.	24	s.	23	12	10	9		0.0	0.0
Fort Smith	457	79	94	29.43	29.90	−.03	65.2	−4.4	89	19	76	43	11	55	29	57	51	65	3.06	−1.8	8	6,118	e.	70	nw.	28	12	12	7	4.7	0.0	0.0
Little Rock	357	136	144	29.54	29.91	−.04	65.6	−4.7	88	28	76	44	11	56	29	57	51	64	2.44	−2.7	9	7,197	s.	37	nw.	28	14	7	10	4.6	0.0	0.0
Brownsville	57	53	61	29.80	29.86		77.4		94	26	85	60	1	70	24	71	70	83	3.60		11	6,588	s.	31	e.	15	8	16	7	5.6	0.0	0.0
Corpus Christi	20	11	73	29.89	29.91	+.01	74.1	−2.4	89	26	80	59	16	68	20	70	68	82	7.07	+4.3	13	10,185	se.	56	se.	26	5	11	15	6.5	0.0	0.0
Dallas	512	109	117	29.39	29.93		69.7		92	20	79	49	11	60	27				3.72		11	6,231	s.	31	s.	23	13	10	8	4.9	0.0	0.0
Fort Worth	670	106	114	29.20	29.90	−.01	69.0	−4.2	95	20	79	46	11	59	32	60	54	64	4.00	−0.2	10	6,552	s.	34	sw.	20	10	8	8	5.1	0.0	0.0
Galveston	54	106	114	29.89	29.95	+.01	72.9	−1.9	85	21	78	59	10	68	21	68	65	80	3.33	+0.1	10	7,571	se.	56	nw.	21	9	18	4	4.5	0.0	0.0
Groesbeck	461	11	56	29.44	29.92		68.7		89	27	79	46	11	59	32				7.29		10	7,723	s.	50	n.	20	12	9	10	5.2	0.0	0.0
Houston	138	111	121	29.79	29.93		73.7	−1.8	93	27	82	56	10	65	27				7.11		11	4,805	s.	37	ne.	20	9	15	7	5.3	0.0	0.0
Palestine	510	64	72	29.41	29.94	+.01	68.7	−4.0	89	28	78	47	11	60	29	62	58	72	4.71	−0.2	11	5,756	s.	29	ne.	20	9	13	9	5.3	0.0	0.0
Port Arthur	34	58	66	29.89	29.93		72.6		86	25	79	56	12	66	23	66	63	76	1.80		11	6,552	s.	37	nw.	21	8	15	8	5.0	0.0	0.0
San Antonio	693	119	132	29.18	29.90	.00	71.6	−3.2	94	27	81	53	9	62	27	64	60	73	4.71	+1.8	13	6,097	ne.	39	nw.	5	10	11	10	5.4	0.0	0.0
Taylor	583	55	63	29.34	29.95	+.04	70.5	−3.7	92	27	80	52	8	61	28				5.38	+1.4	10	6,515	s.	36	w.	20	9	11	11	5.6	0.0	0.0

TABLE I.—*Climatological data for Weather Bureau stations, May, 1924*—Continued

Districts and stations	Elevation of instruments: Barometer above sea level	Thermometer above ground	Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Sea level, reduced to mean of 24 hours	Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Departure from normal	Maximum	Date	Mean maximum	Minimum	Date	Mean minimum	Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Departure from normal	Days with 0.01, or more	Wind: Total movement	Prevailing direction	Maximum velocity: Miles per hour	Direction	Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
Ohio Valley and Tennessee							**58.8**	**-6.2**										**69**	**4.68**	**+1.0**										**6.3**		
Chattanooga	762	189	213	29.11	29.91	-.08	63.8	-5.0	87	20	74	44	9	54	34	55	49	62	5.69	+2.1	11	5,836	sw.	44	w.	28	10	15	6	4.9	0.0	0.0
Knoxville	996	102	111	28.86	29.91	-.08	62.6	-4.6	87	5	73	45	17	52	36	55	50	68	4.06	+0.4	3	5,182	sw.	34	sw.	29	7	29	18	6.8	0.0	0.0
Memphis	399	76	97	29.50	29.92	-.04	64.8	-5.8	88	19	73	44	11	56	26	58	53	70	6.36	+2.0	11	4,840	sw.	28	nw.	28	15	8	8	4.5	0.0	0.0
Nashville	546	168	191	29.35	29.94	-.04	62.4	-5.8	86	5	73	42	11	52	32	55	50	67	6.39	+2.9	15	6,824	w.	48	nw.	13	12	8	11	5.0	0.0	0.0
Lexington	989	193	230	28.83	29.89	-.10	58.2	-6.1	84	7	67	42	1	49	35				3.04	-0.5	15	9,768	sw.	64	sw.	24	5	12	14	6.2	0.0	0.0
Louisville	525	219	255	29.33	29.91	-.08	60.0	-6.6	86	6	69	44	25	51	35	52	46	65	3.51	-0.1	15	8,861	s.	50	sw.	24	5	14	11	6.1	0.0	0.0
Evansville	431	139	175	29.44	29.91	-.06	60.2	-6.5	87	5	69	44	11	51	33	53	48	68	3.44	0.0	13	8,192	sw.	42	nw.	23	5	14	12	6.5	0.0	0.0
Indianapolis	822	194	230	28.99	29.88	-.09	56.0	-6.9	84	6	65	39	1	47	32	50	45	69	4.47	+0.5	16	8,297	sw.	42	w.	18	6	15	10	5.9	0.0	0.0
Royal Center	736	11	55	29.05	29.85		52.7		81	6	63	34	21	42	40				3.16		15	7,341	sw.	45	w.	18	2	6	23	7.7	0.0	0.0
Terre Haute	575	96	129	29.26	29.88		57.2		85	6	66	41	25	48	37	50	45	67	4.02		17	7,011	sw.	36	nw.	3	4	14	13	6.7	0.0	0.0
Cincinnati	628	11	51	29.21	29.88	-.11	57.2	-5.9	85	6	67	39	22	48	35		50	78	3.97	+0.4	17	5,251	sw.	36	sw.	3	5	12	14	6.6	0.0	0.0
Columbus	824	179	222	29.00	29.88	-.10	55.4	-6.9	85	7	64	37	22	46	30	50	46	75	3.43	-0.3	15	7,615	w.	50	w.	18	4	12	15	6.9	0.0	0.0
Dayton	899	137	173	28.91	29.87		56.2	-6.7	84	6	65	37	22	47	30	50	45	71	3.63	-0.2	19	7,103	sw.	40	w.	18	6	11	14	6.4	0.0	0.0
Elkins	1,947	59		27.84	29.89	-.11	52.6	-6.6	81	6	63	32	5	42	41	48	43	73	8.88	+4.9	21	4,350	w.	36	Sw.	24	3	9	19	7.5	T.	0.0
Parkersburg	638	77	84	29.24	29.89	-.10	57.7	-6.1	90	7	67	36	5	48	40	51	46	69	4.05	+0.6	18	4,124	sw.	32	w.	3	8	6	17	6.5	0.0	0.0
Pittsburgh	842	353	410	28.96	29.86	-.13	55.4	-7.0	84	7	64	40	1	47	32	49	43	65	4.54	+1.2	18	8,624	sw.	44	sw.	3	4	10	17	7.2	0.0	0.0
Lower Lake Region							**51.2**	**-6.3**										**71**	**3.13**	**0.0**										**6.4**		
Buffalo	767	247	280	29.01	29.84	-.13	48.3	-6.3	73	7	55	32	2	42	30	44	41	79	2.59	-0.5	16	14,359	sw.	56	sw.	24	4	16	11	6.4	0.1	0.0
Canton	448	10	61	29.30	29.77		49.2	-7.0	72	18	58	29	3	40	26				3.91	+1.1	14	10,566	w.	52	e.	8	9	11	11	5.7	0.0	0.0
Oswego	335	76	91		29.82	-.15	48.7	-6.5	71	17	56	35	21	42	29			70	4.10	+1.2	13	7,768	w.	34	sw.	18	4	13	14		T.	0.0
Rochester	523	86	102	29.27	29.84	-.13	50.6	-6.5	72	17	58	33	2	43	25	45	40	69	3.55	+0.6	17	6,670	w.	38	sw.	24	2	15	14	7.1	0.2	0.0
Syracuse	597	97	113	29.19	29.83	-.15	51.4	-5.9	72	18	59	33	2	44	29				3.06	-0.3	16	8,716	w.	39	sw.	3	3	12	16	6.9	0.1	0.0
Erie	714	130	166	29.07	29.84	-.14	50.6	-6.2	72	17	58	36	2	44	25	47	43	75	4.08	+0.6	14	10,337	w.	42	sw.	24	3	15	13	6.5	0.0	0.0
Cleveland	762	190	201	29.03	29.85	-.13	52.4	-5.5	72	17	60	38	1	45	25	47	42	69	2.62	-0.6	16	9,085	w.	45	w.	24	4	13	14	6.9	0.0	0.0
Sandusky	629	62	70	29.16	29.84	-.14	52.5	-6.7	74	17	60	36	22	45	28				2.23	-1.0	15	6,060	sw.	32	w.	18	4	11	16	6.7	0.0	0.0
Toledo	628	208	243	29.17	29.85	-.12	52.8	-6.6	74	17	61	36	1	45	26	48	43	73	2.03	-1.2	14	10,347	sw.	47	sw.	17	9	13	9	5.5	0.0	0.0
Fort Wayne	856	113	124	28.94	29.86		54.0	-6.2	83	6	64	35	22	44	34	48	43	69	3.39		17	6,691	sw.	36	sw.	17	6	12	13	6.4	0.0	0.0
Detroit	730	218	258	29.06	29.85	-.12	52.2	-5.8	73	17	60	33	1	44	27	45	39	64	3.11	-0.2	12	7,973	nw.	46	sw.	17	6	14	11	5.9	0.0	0.0
Upper Lake Region							**47.9**	**-5.0**										**68**	**3.20**	**-0.2**										**6.1**		
Alpena	609	13	92	29.16	29.83	-.14	45.2	-4.3	72	16	54	27	2	36	32	41	35	69	3.45	+0.1	12	9,227	nw.	46	nw.	24	5	13	13	6.7	T.	0.0
Escanaba	612	54	60	29.17	29.84	-.13	45.2	-4.4	69	28	53	27	2	38	30	41	36	71	2.83	-0.6	12	7,933	s.	35	ne.	28	11	8	12	5.5	T.	0.0
Grand Haven	632	54	89	29.14	29.83	-.13	47.8	-6.7	64	11	55	32	20	41	22	44	39	74	3.68	+0.3	13	7,802	w.	36	s.	17	10	10	11	5.8	0.0	0.0
Grand Rapids	707	70	87	29.07	29.85	-.12	50.7	-8.3	73	17	60	31	1	42	27	45	38	65	3.72	+0.4	14	4,652	w.	28	w.	18	7	8	16	6.5	T.	0.0
Houghton	668	62	99	29.10	29.83	-.14	44.8	-4.7	78	16	53	26	2	36	38				1.62	-1.7	10	8,661	w.	45	ne.	8	8	13	10	6.1	0.4	0.0
Lansing	878	11	62	28.89	29.84		50.6	-7.3	74	17	62	29	1	40	31	45	40	69	4.20	+0.6	13	4,582	w.	24	sw.	17	6	14	11	6.1	T.	0.0
Ludington	637	60	66	29.13	29.83		46.0		65	31	52	29	2	40	22	42	38	75	1.81		13	7,428	s.	36	s.	23	11	10	10	5.2	T.	0.0
Marquette	734	77	111	29.06	29.86	-.11	44.1	-4.9	78	16	51	25	2	37	33	39	33	67	3.31	0.0	14	6,797	nw.	31	nw.	18	7	7	17	6.6	0.6	0.0
Port Huron	638	70	120	29.13	29.83	-.14	49.4	-5.8	72	17	58	32	1	41	25	45	39	70	3.51	+0.3	12	8,078	ne.	34	nw.	24	3	21	7	5.6	T.	0.0
Saginaw	641	69	77	29.14	29.83		49.8		74	17	59	29	1	40	27	44	39	70	3.08	-1.0	13	6,667	sw.	36	sw.	17	2	15	14	7.1	T.	0.0
Sault Sainte Marie	614	11	52	29.13	29.82	-.13	44.9	-4.1	70	16	53	26	3	36	36	40	34	68	1.58	-1.7	11	7,492	nw.	45	nw.	18	8	11	12	6.1	1.1	0.0
Chicago	823	140	310	28.97	29.86	-.10	54.4	-4.1	84	5	62	38	1	47	37	46	39	60	2.30	-1.1	13	7,802	w.	38	s.	23	9	11	11	5.8	T.	0.0
Green Bay	617	109	144	29.14	29.80	-.15	49.2	-5.3	71	16	57	33	2	41	28	45	40	73	4.72	+1.2	18	8,580	ne.	39	nw.	23	5	12	14	6.5	T.	0.0
Milwaukee	681	125	139	29.09	29.83	-.13	50.0	-4.1	72	16	57	35	1	43	27	45	40	70	3.87	+0.4	13	6,820	w.	31	ne.	5	9	8	14	6.2	T.	0.0
Duluth	1,133	5	47	28.64	29.86	-.10	45.8	-1.5	75	16	56	28	18	36	31	39	30	57	2.91	-0.6	10	11,948	nw.	46	ne.	8	8	12	11	5.8	5.7	0.0
North Dakota							**47.6**	**-6.5**										**58**	**0.86**	**-1.6**										**5.6**		
Moorhead	940	50	58	28.91	29.93	-.01	46.8	-8.3	79	15	58	27	22	36	41	41	33	62	0.78	-2.2	10	6,871	n.	34	nw.	21	10	15	6	5.1	0.5	0.0
Bismarck	1,674	8	57	28.22	30.01	+.09	49.2	-5.3	81	15	62	26	25	36	43	41	32	57	0.45	-2.0	5	7,766	n.	52	nw.	17	8	9	14	6.5	1.4	0.0
Devils Lake	1,478	11	44	28.38	29.97	+.03	45.6	-7.1	79	15	57	25	19	34	37	38	30	57	1.24	-1.0	9	8,824	n.	38	n.	13	8	12	11	5.7	5.2	0.0
Ellendale	1,457	10	56	28.39	29.96		47.8		75	15	61	25	24	35	48				0.85		7	12,341	n.	54	n.	17	5	16	10	6.0	2.4	0.0
Grand Forks	835	12	89				45.6		79	15	58	43	13	34	42	40			2.38		12		n.	50	w.	26	13	6	12		6.7	0.0
Williston	1,878	41	48	28.01	30.00	+.07	48.6	-5.4	80	15	61	27	13	36	38	40	31	57	0.99	-1 3	6	6,371	ne.	43	nw.	17	11	12	8	4.7	4.3	0.0
Upper Mississippi Valley							**55.2**	**-6.7**										**65**	**2.57**	**-1.7**										**5.7**		
Minneapolis	918	102	208	28.86	29.84		50.4		79	16	60	32	9	41	28				1.03	-2.9	12	9,318	nw.	45	nw	18	9	10	12	6.1	0.5	0.0
St. Paul	837	236	261	28.95	29.85	-.09	49.8	-8.1	76	16	59	33	9	40	29				1.47	-2.2	12	10,176	nw.	42	nw.	18	11	12	8	5.0	T.	0.0
La Crosse	714	11	48	29.07	29.84	-.10	52.0	-7.3	76	16	62	34	9	42	32				1.75	-2.0	16	3,530	w.	21	w.	3	5	15	11	6.2	T.	0.0
Madison	974	70	78	28.80	29.86	-.10	51.2	-6.4	84	5	60	34	19	43	44	45	39	68	1.46	-2.2	17	6,266	nw.	28	se.	5	7	9	15	6.3	T.	0.0
Wausau	1,247	4		28.49	29.82		46.4		70	16	55	28	2	38	31				3.07		12		nw.				13	2	16	5.5	T.	0.0
Charles City	1,015	10	49	28.79	29.87	-.07	51.2	-8.3	90	5	62	33	11	41	39	45	38	64	2.21	-2.7	15	4,619	nw.	27	sw.	5	8	9	14	5.7	0.0	0.0
Davenport	606	71	79	29.19	29.85	-.10	55.9	-5.4	86	5	66	39	20	46	38	49	42	63	0.93	-3.3	13	5,198	nw.	23	nw.	6	10	7	14	5.7	0.0	0.0
Des Moines	861	84	97	28.97	29.87	-.06	55.7	-5.6	88	5	66	36	24	46	35	48	40	59	1.26	-3.3	11	5,412	nw.	42	sw.	5	11	6	14	5.6	0.0	0.0
Dubuque	700	81	96	29.08	29.83	-.12	53.8	-6.5	88	5	63	33	20	44	42	46	40	64	2.16	-2.2	11	4,650	nw.	26	n.	23	6	9	16	7.0	0.0	0.0
Keokuk	614	64	78	29.20	29.88	-.06	57.4	-6.4	86	5	67	41	24	47	32	49	42	61	2.39	-1.9	11	5,734	w.	36	sw.	2	10	7	14	5.4	0.0	0.0
Cairo	358	87	93	29.52	29.90	-.06	61.6	-6.8	86	5	71	43	11	53	28	54	49	68	5.64	+1.8	13	6,447	s.	48	nw.	23	8	13	10	5.7	0.0	0.0
Peoria	609	11	45	29.21	29.87	-.09	55.5	-6.2	86	5	67	36	21	44	39	49	44	68	1.91	-2.4	14	4,316	nw.	25	nw.	17	15	8	8	4.6	0.0	0.0
Springfield, Ill	636	10	91	29.18	29.86	-.09	57.4	-5.8	87	5	67	41	25	48	38	51	45	68	3.83	-0.7	15	5,965	w.	28	sw.	17	8	11	12	5.7	0.0	0.0
Hannibal	534	74	109	29.29	29.86	-.08	56.8	-6.8	86	5	67	40	22	47	33				3.80	-1.2	14	6,497	sw.	38	sw.	23	9	11	11	5.6	0.0	0.0
St. Louis	568	265	303	29.27	29.88	-.07	59.4	-7.5	86	5	68	42	14	51	28	52	47	68	6.18	+1.9	15	9,554	nw.	59	s.	23	[illegible]	8	14	5.7	0.0	0.0
Missouri Valley							**55.5**	**-5.9**										**62**	**2.38**	**-1.9**										**5.5**		
Columbia, Mo	784	11	84	29.05	29.89	-.05	57.4	-6.9	86	5	68	37	9	47	31				5.11	+0.2	15	5,814	nw.	28	w.	23	8	10	13	5.9	0.0	0.0
Kansas City	963	161	181	28.88	29.91	-.01	58.7	-6.1	87	4	68	37	9	49	32	50	44	64	3.60	-1.5	13	8,956	nw.	41	n.	23	12	9	10	4.8	0.0	0.0
St. Joseph	967	11	49	28.87	29.90		58.1		88	4	69	36	9	47	34	49	42	64	2.24		13	6,588	nw.	34	nw.	23	11	11	9	4.8	0.0	0.0
Springfield, Mo	1,324	98	104	28.52	29.92	-.01	57.7	-6.8	81	4	67	34	10	49	28	51	46	69	6.02	+0.5	13	7,045	nw.	37	w.	28	15	7	9	4.4	0.0	0.0
Iola	984	11	50	28.88	29.91	-.01	60.0	-4.5	87	4	72	38	9	48	36				2.76	-2.3	8	4,805	n.	28	n.	23	15	6	10	4.8	0.0	0.0
Topeka	987	92	107				58.8	-5.5	89	4	70	36	9	48	37				2.11	-2.8	10	7,898	sw.	41	n.	23	11	9	11	5.2	0.0	0.0
Drexel	1,299	10	54	28.51	29.91		53.3		88	5	64	32	24	42	37				2.33		14	7,270	nw.	42	sw.	5	10	4	17	6.3	T.	0.0
Lincoln	1,189	11	84	28.65	29.92	+.01	55.7	-6.0	90	5	67	34	24	44	39	47	39	59	2.20	-2.0	11	7,889	nw.	36	nw.	23	9	8	14	6.1	T.	0.0
Omaha	1,105	115	122	28.73	29.91	-.01	55.7	-6.7	91	5	66	34	9	46	33	48	42	64	2.01	-2.5	14	6,801	nw.	37	nw.	23	9	8	14	5.9	T.	0.0
Valentine	2,598	47	54	27.24	29.96	+.06	51.1	-5.1	90	4	64	30	8	38	48	43	34	58	0.56	-2.8	8	7,708	n.	36	nw.	6	7	12	12	5.9	T.	0.0
Sioux City	1,135	94	164	28.71	29.92	.00	53.8	-6.6	92	5	65	34	24	43	36	46	37	58	1.52	-2.8	10	9,011	nw.	51	nw.	17	7	13	11	5.8	0.5	0.0
Huron	1,306	59	74	28.56	29.96	+.04	51.2	-5.2	81	16	64	29	24	39	45	43	36	62	1.15	-1.8	11	7,477	nw.	40	n.	23	13	9	9	5.1	T.	0.0
Pierre	1,572	70	75	28.29	29.95	+.04	53.2	-4.8	84	4	66	31	24	41	43	44	35	58	0.24	-1.9	8	7,296	nw.	42	nw.	17	6	13	12	5.7	0.2	0.0
Yankton	1,233	49	57	28.61	29.92	.00	53.0	-6.4	92	5	64	32	24	42	39				1.25	-2.6	10	6,041	nw.	35	w.	5	6	14	11	6.0	T.	0.0

TABLE I.—*Climatological data for Weather Bureau stations, May, 1924*—Continued

Districts and stations	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
Northern Slope							**51.3**	**−1.4**										**56**	**1.69**	**−0.7**										**4.7**		
Billings	3,140	5					53.2		85	3	70	27	10	37	50				2.05		5		nw.				19	5	7		0.0	0.0
Havre	2,505	11	44	27.37	30.00	+.10	53.0	−0.4	90	15	67	31	9	39	49	44	35	61	0.78	−1.3	10	4,516	e.	32	n.	5	14	10	7	4.1	T.	0.0
Helena	4,110	87	112	25.81	29.98	+.05	53.9	+2.3	82	15	66	33	5	41	41	43	43	52	0.87	−1.1	8	6,599	sw.	31	sw.	22	12	10	9	4.6	1.0	0.0
Kalispell	2,973	48	56	26.91	29.94	+.06	55.4	+4.0	85	15	70	30	6	41	39	43	30	47	0.39	−1.6	5	4,655	nw.	27	w.	24	15	13	3	3.4	0.0	0.0
Miles City	2,371	48	55	27.49	30.05	+.14	52.8	−3.9	87	3	64	28	7	41	41	44	35	56	0.34	−1.6	7	4,317	nw.	30	w.	17	14	7	10	4.4	T.	0.0
Rapid City	3,259	50	58	26.61	30.02	+.12	50.7	−3.3	82	16	63	28	24	39	36	42	33	54	0.53	−2.4	9	7,030	n.	38	n.	16	9	8	14	6.0	0.2	0.0
Cheyenne	6,088	84	101	24.00	29.96	+.11	45.8	−4.5	75	16	58	24	7	34	36	39	33	64	3.58	+1.2	11	8,979	n.	48	nw.	18	9	9	13	5.5	T.	0.0
Lander	5,372	60	68	24.65	29.98	+.10	50.3	−0.9	78	16	63	28	6	38	39	41	31	54	6.06	+3.2	8	4,150	e.	54	w.	4	14	10	7	4.6	12.0	3.4
Sheridan	3,790	10	47	26.13	30.03		49.8		82	3	63	28	10	36	46	42	34	62	1.51		14	4,469	nw.	46	nw.	6	11	9	11	5.2	T.	0.0
Yellowstone Park	6,200	11	48	23.89	29.98	+.07	46.8	−0.6	74	15	61	21	6	33	42	37	28	54	0.43	−1.5	7	5,351	nw.	39	n.	22	12	11	8	4.3	1.1	0.0
North Platte	2,821	11	51	27.06	29.98	+.10	53.2	−5.5	92	4	66	30	8	40	48	44	35	59	2.26	−0.8	11	5,992	n.	31	nw.	6	14	4	13	5.3	0.0	0.0
Middle Slope							**57.5**	**−5.0**										**60**	**2.04**	**−1.8**										**5.0**		
Denver	5,292	106	113	24.72	29.95	+.11	52.6	−3.6	82	18	64	32	9	41	36	43	33	56	2.62	+0.1	11	5,303	n.	37	ne.	23	11	11	9	5.4	0.6	0.0
Pueblo	4,685	80	86	25.26	29.91	+.08	55.2	−4.0	83	17	68	32	15	42	43	44	34	54	1.76	+0.1	8	4,757	se.	33	nw.	26	10	14	7	5.2	0.0	0.0
Concordia	1,392	50	58	28.45	29.92	+.01	57.4	−5.8	86	5	69	34	11	46	34	48	40	57	1.75	−3.0	10	6,554	nw.	32	sw.	5	9	12	10	5.4	0.0	0.0
Dodge City	2,509	11	51	27.38	29.97	+.10	57.0	−6.5	88	17	70	31	10	44	39	48	41	62	0.63	−2.7	8	6,666	nw.	33	sw.	22	16	9	6	4.0	0.0	0.0
Wichita	1,358	139	158	28.49	29.92	+.02	59.3	−5.8	83	4	70	38	11	49	38	51	43	60	2.93	−2.0	7	9,102	s.	39	s.	5	13	12	6	4.5	0.0	0.0
Broken Arrow	765	11	52	29.10	29.92		62.0		85	23	72	40	11	52	31				1.40		6	9,021	s.	49	n.	3	10	11	10	5.2	0.0	0.0
Muskogee	652	4					64.6		89	4	76	41	1	53	33				4.96		9		nw.				12	10	9		0.0	0.0
Oklahoma City	1,214	10	47	28.65	29.92	+.03	63.3	−4.4	90	23	74	40	10	53	39	56	51	69	2.58	−3.2	7	7,379	s.	37	n.	23	8	14	9	5.3	0.0	0.0
Southern Slope							**66.8**	**−3.8**										**60**	**1.83**	**−0.9**										**4.6**		
Abilene	1,738	10	52	28.11	29.90	+.03	68.3	−3.6	95	27	80	44	1	56	31	58	52	66	5.17	+1.4	10	6,690	s.	39	sw.	23	8	15	8	5.1	0.0	0.0
Amarillo	3,676	10	49	26.24	29.93	+.09	60.7	−3.6	92	17	74	39	11	47	42	52	47	66	0.67	−3.0	11	6,913	n.	32	se.	21	16	12	3	4.0	0.0	0.0
Del Rio	944	64	71	28.90	29.88	+.03	73.0	−3.9	101	27	83	48	16	64	34				1.33	−1.0	10	6,971	se.	44	n.	5	12	9	10	5.0	0.0	0.0
Roswell	3,566	75	85	26.29	29.84	+.02	65.1	−4.3	93	23	79	42	3	51	47	51	39	47	0.15	−1.0	2	5,953	s.	30	sw.	25	12	15	4	4.2	0.0	0.0
Southern Plateau							**68.0**	**+2.5**										**33**	**0.18**	**−0.2**										**1.9**		
El Paso	3,762	110	133	26.10	29.77	−.01	72.2	+0.1	93	18	85	50	3	60	36	52	32	30	T.	−0.4	0	8,355	w.	45	n.	2	24	7	0	2.4	0.0	0.0
Santa Fe	7,013	38	53	23.21	29.77	−.04	56.0	+0.3	77	20	69	34	7	43	31	42	28	39	0.85	−0.3	6	5,200	se.	36	w.	28	14	15	2	4.1	0.0	0.0
Flagstaff	6,907	10	59	23.33	29.82	+.04	52.2	+1.5	79	17	69	27	14	36	45	38		43	0.03		1	6,714	s.	36	nw.	27	20	10	1		0.0	0.0
Phoenix	1,108	11	81	28.64	29.77	−.01	78.8	+3.8	104	17	95	56	1	63	41	57	87	27	0.01	0.0	1	4,301	w.	32	nw.	30	29	2	0	0.7	0.0	0.0
Yuma	141	9	54	29.62	29.76	−.03	79.1	+2.9	108	16	97	56	5	61	45	59	42	35	0.06	0.0	1	3,086	sw.	22	n.	30	31	0	0	0.4	0.0	0.0
Independence	3,957	5	25	25.91	29.88	+.04	69.5	+6.5	93	16	85	47	3	54	38	48	25	24	T.	−0.2	0	6,973	nw.	39	nw.	22	26	5	0	1.8	0.0	0.0
Middle Plateau							**60.8**	**+4.9**										**36**	**0.7**	**−00.4**										**3.1**		
Reno	4,532	74	81	25.43	29.87	−.04	62.6	+9.0	90	16	79	30	5	46	43	45	29	34	T.	−0.7	0	5,952	w.	46	nw.	12	24	6	1	2.2	0.0	0.0
Tonopah	6,090	12	20	24.02	29.82		62.2		82	17	73	32	5	51	31	46	31	34	T.		0		w.								0.0	0.0
Winnemucca	4,344	18	56	25.58	29.92	+.01	60.6	+6.7	89	16	79	27	5	43	48	43	25	33	0.27	−0.8	3	5,303	ne.	35	s.	25	18	12	1	3.0	0.0	0.0
Modena	5,479	10	43	24.58	29.86	+.04	57.3	+3.8	85	16	74	30	8	40	46	42	26	38	0.39	−0.5	3	8,200	sw.	54	nw.	26	18	8	5	3.3	0.0	0.0
Salt Lake City	4,360	163	203	25.56	29.87	+.01	62.0	+4.6	85	12	73	36	6	51	30	47	32	36	1.15	−0.8	7	5,749	nw.	36	s.	4	20	3	8	3.3	0.0	0.0
Grand Junction	4,602	60	68	25.30	29.84	+.01	61.5	+0.4	6	17	75	37	7	48	38	46	30	39	1.69	+0.8	8	4,381	se.	29	w.	19	18	8	5	3.6	0.0	0.0
Northern Plateau							**62.3**	**+6.2**										**40**	**0.13**	**−1.6**										**3.3**		
Baker	3,471	48	53	26.43	29.99	+.03	57.2	+6.5	85	15	74	27	5	41	45	45	32	46	0.29	−1.4	4	4,840	se.	25	n.	28	14	12	5	4.1	0.1	0.0
Boise	2,739	78	86	27.10	29.92	−.02	63.8	+6.7	90	11	79	34	6	49	38	48	31	35	0.05	−1.2	2	4,423	w.	30	nw.	4	23	7	1	2.4	T.	0.0
Lewiston	757	40	48	29.17	29.97	+.01	65.8	+6.3	96	11	83	36	6	49	46				T.	−1.6	0	2,976	e.	29	nw.	24	14	11	6	3.7	0.0	0.0
Pocatello	4,477	60	68	25.42	29.88	−.01	58.3	+4.5	84	15	73	26	6	44	40	43	28	38	0.31	−1.9	5	5,836	se.	50	sw.	4	17	12	2	3.6	T.	0.0
Spokane	1,929	101	110	27.94	29.96	.00	62.2	+6.7	89	15	76	36	6	48	40	48	34	41	0.11	−1.5	3	4,548	sw.	26	s.	18	14	17	0	3.6	0.0	0.0
Walla Walla	991	57	65	28.89	29.96	.00	66.4	+6.8	94	12	80	41	1	52	37	51	37	39	T.	−1.8	0	3,693	sw.	22	nw.	29	24	5	2	2.3	0.0	0.0
North Pacific Coast Region							**56.4**	**+2.7**										**72**	**0.49**	**−2.0**										**5.6**		
North Head	211	11	56	29.88	30.12	+.00	51.2	+0.3	63	30	55	42	3	48	15	49	48	89	0.49	−1.9	7	11,816	n.	51	nw.	9	1	3	27	8.8	0.0	0.0
Port Angeles	29	8	53		30.11		52.8		81	12	61	36	5	44	33				0.17		5	5,214	sw.	30	w.	24	12	12	7		0.0	0.0
Seattle	125	215	250	29.98	30.10	+.09	57.4	+2.9	80	12	66	41	5	49	28	50	44	67	0.68	−1.3	4	5,538	n.	25	s.	4	9	14	8	5.5	0.0	0.0
Tacoma	213	113	120	29.87	30.08	+.06	56.9	+2.8	78	12	66	40	3	48	31				0.20	−2.0	3	5,905	n.	36	sw.	12	7	14	10	5.9	0.0	0.0
Tatoosh Island	86	9	57	30.00	30.11	+.10	49.8	+0.2	62	11	53	41	4	46	13	48	47	94	0.54	−3.6	10	7,552	sw.	44	s.	12	5	11	15	6.8	0.0	0.0
Yakima	1,071	5					65.4		95	11	82	28	5	48	46				0.04		2		nw.				15	13	3		0.0	0.0
Medford	1,425	4					63.2		95	31	83	28	5	44	48	50	35	51	0.15		3		nw.	20	nw.	24	13	9	9	3.3	0.0	0.0
Portland, Oreg	153	68	106	29.91	30.06	+.03	61.2	+4.3	88	11	72	41	3	50	35	54	49	67	0.45	−1.8	3	4,427	nw.	26	sw.	12	6	12	13	6.4	0.0	0.0
Roseburg	510	9	57	29.51	30.06	+.03	61.6	+5.6	94	31	77	37	5	46	44	51	43	61	0.60	−1.4	1	2,677	n.	26	sw.	4	20	9	2	2.7	0.0	0.0
Middle Pacific Coast Region							**61.1**	**+3.1**										**62**	**0.03**	**−1.2**										**3.5**		
Eureka	62	73	89	30.01	30.08	+.03	52.4	+0.4	70	30	57	42	2	48	21	49	47	85	0.08	−2.5	3	4,619	n.	35	n.	28	10	5	16	6.3	0.0	0.0
Point Reyes	490	7	18	29.41	29.93		51.6	0.0	70	30	56	44	8	48	19				T.		0	17,375	nw.	72	nw.	26	12	4	15	6.0	0.0	0.0
Red Bluff	332	50	56	29.54	29.88	−.07	73.8	+7.5	102	16	89	46	5	59	40	56	41	37	0.01	−1.3	1	5,007	se.	29	nw.	27	29	2	0	1.3	0.0	0.0
Sacramento	69	106	117	29.82	29.89	−.05	68.5	+5.2	97	16	83	44	4	54	39	56	47	55	0.06	−0.9	1	7,388	s.	33	nw.	29	28	3	0	1.0	0.0	0.0
San Francisco	155	208	243	29.79	29.96	−.03	59.1	+2.3	88	28	66	47	9	52	30	52	47	73	T.	−0.8	0	7,589	w.	35	w.	3	15	10	6	4.0	0.0	0.0
San Jose	141	12	110	29.80	29.94		62.6		93	28	77	39	5	48	43				0.05	−0.6	1	5,135	nw.	24	nw.	9	23	7	1	2.3	0.0	0.0
South Pacific Coast Region							**65.6**	**+3.5**										**65**	**T.**	**−0.6**										**3.2**		
Fresno	327	89	98	29.52	29.87	−.05	72.6	+5.5	102	16	88	46	5	57	36	56	42	42	T.	−0.6	0	6,183	nw.	32	nw.	3	25	4	2	1.6	0.0	0.0
Los Angeles	338	159	191	29.57	29.93	−.02	64.8	+2.6	92	7	73	54	13	57	33	57	53	73	0.00	−0.5	0	3,986	sw.	16	sw.	12	16	9	6	4.0	0.0	0.0
San Diego	87	62	70	29.84	29.92	−.03	63.0	+2.2	78	16	68	54	6	58	18	58	56	80	0.00	−0.4	0	4,796	w.	28	s.	29	14	8	9	4.6	0.0	0.0
San Luis Obispo	201	32	40	29.75	29.97	−.03	61.8	+3.6	97	15	73	44	3	50	42	52	46	66	T.	−0.9	0	3,405	nw.	17	w.	5	22	8	1	2.6	0.0	0.0
West Indies																																
San Juan, P. R	82	9	54	29.90	29.99		79.0	+0.4	90	22	84	72	5	74	15				5.87	+1.1	20	7,736	e.	32	e.	15	6	23	2	5.2	0.0	0.0
Panama Canal																																
Balboa Heights	118	7	97	29.72	29.84	+.01	80.6	0.0	92	4	87	73	29	75	18	76	75	90	5.51	−2.6	23	4,566	nw.	28	n.	14	0	10	21	7.7	0.0	0.0
Colon	36	7	97	29.82	29.85	+.01	81.0	+0.5	92	26	86	74	12	76	16	77	75	86	14.86	+2.4	25	5,396	n.	30	w.	13	2	5	24	8.0	0.0	0.0
Alaska																																
Juneau	80	11	54				47.8		68	13	54	34	5	41	25	44	40	76	7.44		22	5,306	s.	30	se.	23	1	9	21	8.4	0.0	0.0

TABLE II.—*Data furnished by the Canadian Meteorological Service, May, 1924*

Stations	Altitude above mean sea level, Jan. 1, 1919	Pressure: Station reduced to mean of 24 hours	Pressure: Sea level reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷2	Temperature of the air: Departure from normal	Temperature of the air: Mean maximum	Temperature of the air: Mean minimum	Temperature of the air: Highest	Temperature of the air: Lowest	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Total snowfall
	Feet	*In.*	*In.*	*In.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	*In.*	*In.*	*In.*
Father Point, Que	20	29.75	29.77	−.16	40.6	−3.4	48.2	33.0	73	26	4.97	+2.39	0.0
Quebec, Que	296	29.47	29.78	−.16	48.4	−1.5	56.4	40.5	74	30	4.57	+1.49	T.
Montreal, Que	187	29.57	29.78	−.16	50.2	−4.5	57.7	42.8	73	33	4.75	+1.80	T.
Ottawa, Ont	236	29.52	29.77	−.17	50.1	−4.8	59.2	41.0	71	29	3.79	+1.20	0.2
Kingston, Ont	285	29.50	29.81	−.15	48.5	−4.4	55.0	41.9	64	34	4.36	+1.68	0.0
Totonto, Ont	379	29.41	29.82	−.16	50.1	−3.1	58.6	41.5	70	30	4.41	+1.37	0.0
White River, Ont	1,244	28.46	29.78	−.17	41.2	−4.5	53.7	28.6	71	16	2.00	+0.05	4.4
Parry Sound, Ont	688	29.10	29.79	−.16	47.9	−3.2	57.7	38.1	68	30	4.76	+1.83	0.5
Port Arthur, Ont	644	29.12	29.83	−.13	44.8	−1.1	54.9	34.8	70	22	0.28	−1.87	0.0
Qu'Appelle, Sask	2,115	27.73	29.98	+.04	45.5	−4.3	59.4	31.6	75	21	0.56	−1.09	2.0
Swift Current, Sask	2,392	27.43	29.95	+.03	49.1	−1.6	63.7	34.6	77	25	2.77	+1.01	1.0
Prince Albert, Sask	1,450	28.48	30.07	+.12	48.0	+0.4	62.6	33.4	80	22	0.04	−1.22	T.
Battleford, Sask	1,592	28.26	30.00	+.08	50.1	−0.9	65.2	35.1	83	25	0.71	−0.91	6.5
Victoria, B. C	230	29.83	30.09	+.09	54.6	+2.1	62.4	46.9	83	37	0.09	−1.39	0.0

LATE REPORTS, APRIL, 1924

Stations	Altitude	Station pressure	Sea level pressure	Departure	Mean	Departure	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure	Total snowfall
Sydney, C. B. I	48	29.89	29.94	+.05	34.7	−0.3	41.8	27.7	57	10	3.52	−0.33	16.0
Halifax, N. S	88	29.82	29.93	−.03	38.4	+0.6	46.3	30.5	56	24	3.32	−0.86	3.7
Yarmouth, N. S	65	29.81	29.88	−.08	38.6	−0.3	45.5	31.7	55	21	2.70	−0.69	3.7
Charlottetown, P. E. I	38	29.88	29.92	+.02	34.1	−1.1	40.2	28.0	53	11	1.97	−0.68	18.5
Chatham, N. B	20	29.85	29.88	−.02	32.4	−3.1	40.3	24.6	58	5	3.91	+1.28	27.0
Winnipeg, Man	760	29.05	29.89	−.13	35.9	0.0	43.6	28.1	65	8	3.52	+2.47	7.4
Calgary, Alb	3,428	26.35	29.96	+.06	38.3	−1.3	52.1	24.6	72	10	1.25	+0.61	11.9
Kamloops, B. C	1,262	28.75	30.06	+.13	48.1	−0.8	60.4	35.9	78	24	0.35	−0.04	------
Barkerville, B. C	4,180	25.60	29.96	+.10	31.1	−2.0	39.1	23.1	58	9	3.80	+1.98	37.3

SEISMOLOGICAL REPORTS FOR MAY, 1924

W. J. HUMPHREYS, Professor in Charge

[Weather Bureau, Washington, July 3, 1924]

TABLE 1.—*Noninstrumental earthquake reports, May, 1924*

Day	Approximate time, Greenwich civil	Station	Approximate latitude	Approximate longitude	Intensity Rossi-Forel	Number of shocks	Duration	Sounds	Remarks	Observer
		CALIFORNIA								
1924	*H. m.*		° ′	° ′			*M. s.*			
May 7	?	Whittier	34 00	118 04					No damage	Press report.
23	7 20	Calexico	32 41	115 30		1			Felt by several	E. M. Anderson.
26	11 05	Salinas	36 41	121 39	2	1		None		E. D. Eddy.
		WASHINGTON								
27	0 19	Walla Walla	46 05	118 20		4	1	do	Felt by many	C. C. Garrett.

TABLE 2.—*Instrumental seismological reports, May, 1924*

[Time used: Mean Greenwich, midnight to midnight. Nomenclature: International. For description of stations and instruments see REVIEW for January, 1924]

ALASKA.—*U. S. C. and G. S. Magnetic Observatory, Sitka*

Date	Character	Phase	Time	Period T	Amplitude A_E	Amplitude A_N	Distance	Remarks
1924			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
May 1		eP_E	20 04 13	8			6,440	Phases ill defined; first two on EW may be micros.
		$ePR2_E$	20 07 53	8				
		eS_E	20 12 13					
		eS_N	20 12 25					
		$eSR2_N$	20 19 52					
		eL_E	20 24 57					
		eL_N	20 25 56					
		eL_E	20 26 35					
		M_E	20 37 10	12	*200			
		M_N	20 35 50	16		*200		
		F_E	21 04 ..					
		F_N	21 03 ..					
4		P_E	17 10 10					M uncertain; paper changed in middle of quake.
		P_N	17.09 56					
		M_E	17 13 30	8	*300			
		M_N	17 17 12	12		*200		
		F_E	17 35 ..					
		F_N	17 37 ..					

ARIZONA.—*U. S. C. and G. S. Magnetic Observatory, Tucson*

Date	Character	Phase	Time	Period T	Amplitude A_E	Amplitude A_N	Distance	Remarks
1924			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
May 1		P_E	20 00 18	6				NS record defective; phases not well defined.
		eS_E	20 06 05	7				
		eL_E	20 09 13	15				
		eL_N	20 09 51					
		M_E	20 10 34	8	*2,000			
		M_E	20 21 48	12	*1,800			
		M_N	20 22 ..	14				
		C_E	20 24 ..	12				
		C_N	20 28 ..					
		F_E	21 02 ..					
21		e_E	1 29 09?					May not be seismic.
		P_E	1 29 44	3				
		P_N	1 29 31					
		L_E	1 30 02	4				
		M_E	1 30 09	4	*200			
		F_E	1 38 ..					
		F_N	1 31 ..					

CALIFORNIA.—*Theosophical University, Point Loma*

Date	Character	Phase	Time	Period T	Amplitude A_E	Amplitude A_N	Distance	Remarks
1924			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
May 5			15 00 00		50	50		Tremors during preceding 24 hours.
6					50	50		
22					50	50		
31					50	50		

COLORADO.—*Regis College, Denver*

Date	Character	Phase	Time	Period T	Amplitude A_E	Amplitude A_N	Distance	Remarks
1924			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
1		P_E	20 00 30					Disturbed by hour mark. NS out of order.
		L_E	20 04 ..	5-6	*2,000			
		C_E	20 09 ..					
		F_E	20 19 ..					

DISTRICT OF COLUMBIA.—*U. S. Weather Bureau, Washington*

Date	Character	Phase	Time	Period T	Amplitude A_E	Amplitude A_N	Distance	Remarks
1924			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
May 1		P	20 00 38				3,100	
		S	20 05 29					
		L?	20 08 30					
		F	21 *ca.*					
4		P	17 07 19					
		S	17 15 20					L indistinguishable.
		F	17 45 ..					
6		e_N	16 29 45					
		L	17 28 ..	16				Small amplitude.
		F	17 45 ..					
21		e?	1 37 50					
		F	1 50 ..					
21		P	10 18 42					
		S	10 23 30					No. L.
		F	10 40 ..					
27		e	10 17 50					
		F	10 45 ..					
28		P	10 03 45				8,400	
		S	10 13 26					
		F	10 50 ..					

*Trace amplitude

HAWAII.—*U. S. C. and G. S. Magnetic Observatory, Honolulu*

Date	Character	Phase	Time	Period T	Amplitude A_E	Amplitude A_N	Distance	Remarks
1924			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
May 1		O	19 54 12				6,780	Preliminary phases difficult to distinguish because of microseisms.
		P	20 04 27	4				
		S_E	20 12 45					
		S_N	20 12 55					L^2 is the beginning of regular waves.
		L_E	20 23 00	14				
		L_N	20 22 18	14				
		$L2_E$	20 25 27	8				
		L^2_N	20 24 27	8				
		M_E	20 27 17	7	27			
		M_N	20 27 05	7		36		
		F_E	21 43 ..					
		F_N	21 44 ..					
4		eP_N	16 59 43					Light spot on N was off the paper because of tilt. P_N may have been a few seconds earlier as the 15 seconds time break ended at the recorded time.
		S_N	17 02 16	12				
		L_N	17 03 28	12				
		M_N	17 05 50	12		133		
		F_N	18 24 ..					
6		e_E	6 38 25					
		e_N	6 40 00					
		F_E	6 42 ..					
		F_N	6 44 ..					
6		e_E	10 46 26					
		e_N	10 46 20					
		F	10 52 ..					
6		O	16 11 18				7,720	
		eP_E	16 22 11	2				
		eP_N	16 22 37	3				
		S_E	16 31 30	8				
		S_N	16 31 30	10				
		L_E	16 45 15	25				
		L_N	16 45 10					
		M_E	16 54 48	17	22			
		M_N	16 54 10	17		15		
		F_E	17 17 ..					
		F_N	17 14 ..					
8		e_E	6 03 15					
		e_N	6 02 43					
		F_E	6 07 ..					
		F_N	6 12 ..					
10		e	3 07 49					
		M	3 19 ..	11	7	7		
		F_E	3 30 ..					
		F_N	3 42 ..					
17		eP_E	4 03 17					
		eP_N	4 03 08					
		S_E	4 04 18	8				
		S_N	4 04 23	7				
		L_E	4 04 59	13				
		L_N	4 05 05	13				
		M_E	4 05 50	13	24			
		M_N	4 08 27	11		11		
		F	4 16 ..					
17		e_E	5 37 13					
		e_N	5 36 47					
		F_E	6 09 ..					
		F_N	5 54 ..					
24		O	3 26 12				3,820	
		P	3 33 17					
		eS_N	3 38 54					
		eL_E	3 42 54	20				
		eL_N	3 42 39	15				
		M_E	3 49 24	14	11			
		M_N	3 43 15	15		12		
		C	3 51 ..	11				
		F	4 13 ..					
25		e	13 54 13					
		F	14 12 ..					
28		O	9 52 10				4,940	
		P_E	10 00 31	2				Interpretation doubtful. The phases tabulated as S and L are quite similar in character.
		P_N	10 00 37	5				
		PR_2	10 02 49	6				
		S_E	10 07 13	12				
		S_N	10 07 13	15				
		L_E	10 13 25	11				
		L_N	10 13 37	18				
		M_E	10 07 27	10	22			
		M_N	10 07 34	14		21		
		F	10 35 ..					
27		e	2 54 21					
		F	3 01 ..					

TABLE 2.—*Instrumental seismological reports, May, 1924*—Continued

HAWAII.—*U. S. C. and G. S. Magnetic Observatory, Honolulu*—Contd.

1924			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
May 30		P	19 12 31	5				No definite phases. Slight indication of activity on E at 19:11:09. Evidently not far away.
		L_N	19 13 26	5				
		M_E	19 14 11	5	82			
		M_N	19 14 01	5		60		
		F	19 25 ..					

ILLINOIS.—*U. S. Weather Bureau, Chicago*

1924			*H. m. s.*	*Sec.*	μ	μ	*Km.*
May 1		P	20 00 23				3, 200
		S	20 05 12				
		L?	20 08 25				
		L	20 11 ..	25			
		F	23 30 *ca*				
2		eL	2 29 15	18			
		F	3 *ca*				
4		P	17 07 03				6, 100
		S	17 14 42				
		L?	17 24 00				
		L	17 49 ..	16			
		F	19 30 *ca*				
5		e	6 19 30				
		F	7 15 *ca*				
6		eL	3 40 ..	16			
		F	5 *ca* ..				
6		e	6 38 50				
		L	6 51 30	18			
		F	7 05 ..				
6		i	10 47 50				
		L	11 00 30	15			
		F	11 30 ..				
6		P?	16 28 38				
		S	16 37 18				
		L	17 00 00	45			
		L	17 10 ..	30			
		L	17 16 ..	20			
		F	18 30 *ca*				
7		e	13 05 50				
		F	13 15 *ca*				
8		e	6 04 30				
		F	7 30 *ca*				
10		e	3 15 ..				
		L	4 00 ..	18			
		L	4 03 30	16			
		F	5 *ca*				
17		e?	4 13 ..				
		L?	4 40 ..				
		F	5 40 *ca*				
17		P?	5 36 58				
		S?	5 45 15				
		L	6 19 ..	22			
		L	6 25 ..	18			
		F	7 30 ..				
21		e	1 37 37				
		eL	1 40 52	16			
		F	2 10 *ca*				
21		P	10 18 40				3, 100
		S	10 23 27				
		L	10 27 25	25			
		L	10 33 ..	16			
		F	11 *ca*				
27		P	3 14 18				
		S?	3 20 15				
		L?	3 26 30				
		L	3 28 ..	18			
		F	4 *ca*				
27		e	10 07 30				
		F	11 10 *ca*				
28		P	10 03 18				7, 800
		S	10 12 25				
		L	10 33 ..	23			
		L	10 44 ..	16			
		F	11 40 *ca*				

MARYLAND.—*U. S. C. and G. S. Magnetic Observatory, Cheltenham*

1924			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
May 1		e_N	20 00 14					Faint; phases not well defined; first phase on NS. may not be seismic.
		eP_E	20 00 35	4				
		eP_N	20 00 34	4				
		e_E	20 04 50	4				
		e_N	20 04 52					
		eL_E	20 13 21	15				
		eL_N	20 12 07	17				
		M_E	20 13 32	15	*200			
		M_N	20 15 04	10		*1, 000		
		F_E	20 31 ..					
		F_N	20 31 ..					

PORTO RICO.—*U. S. C. and G. S. Magnetic Observatory, Vieques*

1924			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
May 1		eP_E	19 59 26	9			2, 320	Phases not characteristic; waves irregular. Gentle rocking motion felt at local police station.
		eP_N	19 59 27	6				
		eS_E	20 02 06					
		eS_N	20 03 17	7				
		eL_E	20 03 42	18				
		eL_N	20 03 53	20				
		e_E	20 06 12	30				
		e_N	20 06 07	32				
		e_E	20 09 24	14				
		M_E	20 12 35	16	*13,400			
		M_N	20 10 39	17		*13, 800		
		C_E	20 14 ..	12				
		C_N	20 15 ..	13				
		F_E	21 01 ..	12				
		F_N	20 30 ..	13				
27		P	10 16 45	2				At Port de Paix, Haiti.
		eL_N	10 17 20	3				
		M_E	10 18 52	6	*100			
		M_N	10 17 42	4		*200		
		F	10 24 ..					

CANAL ZONE.—*Panama Canal, Balboa Heights*

1924			*H. m. s.*	*Sec.*	μ	μ	*Miles*
May 1		P_E	19 56 52				1,425 *ca*
		P_N	19 56 58				
		S_E	20 00 38				
		S_N	20 00 38				
		L_E	20 02 22				
		L_N	20 01 30				
		M_E	20 02 44		*3, 600		
		M_N	20 03 52			*3, 000	
		F_E	20 37 50				
		F_N	20 48 00				

VERMONT.—*U. S. Weather Bureau, Northfield*

1924			*H. m. s.*	*Sec.*	μ	μ	*Km.*
May 1		P?	20 01 14				
		S	20 06 40				
		eL	20 10 30				
		L	20 12 ..	22			
		L	20 14 ..	16			
		F	21 *ca.*				
4		e	17 15 ..				
		F	17 30 ..				

CANADA.—*Dominion Observatory, Ottawa*

Instruments—Determined constants

Instrument	To	r	v	ε	Comp.	1	Determined
I	5. 3		120	2: 1	NS.	1 sec. tilt=displ't.	May 7, 1924
II	6. 0		120	15: 1	EW.		Do.
17	12. 0		250	20: 1	EW.	51.0 mm	Do.
23	12. 0		250	20: 1	NS.	44.0 mm	May 5, 1924
D	37. 6			13: 10	EW.		Jan. 7, 1924
D	36. 9			13: 10	NS.		Do.
W	5. 5		160	4: 1	Vert.		Aug. 22, 1923

* Trace amplitude.

Table 2.—*Instrumental seismological reports, May, 1924*—Continued

CANADA.—*Dominican Observatory, Ottawa*—Continued

1924			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
May 1		eL	4 40 ..					
		L	4 42 ..	17				Small sinusoidal.
		L	4 49 ..	15				
		F	5 18 *ca.*					
1		O	19 54 20				3,690	
		P	20 01 15					
		PR1	(20 02 06)					
		PR2	(20 02 24)					
		M_N	20 02 52					Peculiar rise to a maximum on I only.
		S	20 06 44					
		SR2	20 09 00					
		eL	20 10 30					
		M1	20 15 ..	15	57			
		M2	20 17 ..	15	57			
		L	20 41 *to*	11	8			
			22 20 ..	11				
		F	23 20 *ca.*					
			HALIFAX RECORD					
		O	19 54 22				4,140	
		eP	20 01 50					
		i	20 03 24					
		iS	20 07 45					
		i	20 11 00					
		eL	20 12 00					
2		eL	2 35 ..	15				Small.
		L	2 52 ..	15				Do.
		F	3 06 ..					
3		eL?	(12 14 30)					On No. 17 only.
		L	12 24 ..					
		L	12 33 ..	24				Small.
		F	12 49 *ca*					
4		O	16 57 55				6,180	Very difficult to read; interpretation doubtful.
		e17	17 05 37					
		P	17 07 36					
		PR2?	17 10 24					
		e	17 13 13					
		S?	17 15 22					
		i	17 16 28					
		iSR1?	17 19 20					
		iSR2?	17 20 30					
		eL	17 22 49					
		L	17 29 ..					Irregular.
		L	17 37 ..					Do.
		L	17 55 ..	15	5			
		L	18 13 ..	13	3			
		F	19 40 ..					
5		e	6 21 30					
		eL	6 29 ..					Small sinusoidal.
		F	7 00 *ca*					
6		eL	3 45 ..					Small *No. 23 replaced in service after experimental work on May 6.*
		L	3 53 ..	20				
		L	4 17 ..	15				
		F	4 46 ..					
6		e	6 39 47					
		e	6 43 47					
		e	6 47 ..					
		eL	6 51 ..					
		F	7 20 ..					
6		e	10 48 41					
		eL?	10 59 45					
		L	11 03 ..	15				Small.
		F	11 35 ..					
6		P	16 29 26					
		e17	16 37 11					
		e17	16 44 58					
		e	16 48 45					
		eL?17	16 57 30					
		L	17 00 ..	45	50			
		L	17 08 ..	30	25	11		
		L	17 20 ..	18	7	4		
		L	17 22 ..	16	6			
		L	17 30 ..	20	9			
		L	17 39 ..	14	3			Small on NS.
		F	18 40 ..					
7		eL	1 37 ..					Small sinusoidal; barely discernible.
		L	1 39 30	20				
		F	2 22 ..					
		e17	13 10 45					Small; irregular.
		e23	13 10 23					
		F	13 16 ..					
8		e	6 05 45					
		e	6 12 30					
		e	6 20 ..					
		L	6 39 ..	20				Small sinusoidal.
		L	6 49 ..	18				
		L	6 53 ..	18				
		F	8 03 ..					
10		e_E	3 13 15					
		e_E	3 15 53					
		e_E	3 20 08					
		eL_E	3 27 ..					
		L	3 54 ..	20	4.5	3		
		L	4 07 30	17	3.5			
		L	4 18 ..	15	2.5	2		
		F	5 20 *ca*					

CANADA.—*Dominican Observatory, Ottawa*—Continued

1924			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
May 11		e	4 52 00					
		e	4 55 30					
		eL	4 58 30					
		L	5 00 00	20				Small.
		F	5 09 *ca*					
11		L_E	16 44 30					All phases a trifle later on NS than on EW. Maximum difference, 1 minute.
		L	16 48 ..					
		L	16 52 ..					
		L	16 54 ..	18				
		F	17 10 *ca*					
12		e?	13 37 28					Small sinusoidal L wave.
		L	13 43 ..	12				
		L	14 13 ..	20				
		F	14 25 *ca*					
13		eL	2 37 48					
		L	2 39 32					
		L	2 42 ..					Very small.
		F	2 52 ..					
17		e?	4 13 40					
		S?	4 22 10					
		eL	4 39 ..					No. 17 only.
		L	4 44 ..	21				
		L	4 50 ..	18	5			
		L	4 55 ..	17	2			
		L	5 01 ..	16				Small.
		F	5 30 *ca*					
18		e	5 36 30					Early phases lost in coda of preceding quake.
		e	5 38 45					
		eL	5 54 30					
		M	6 24 ..	24	8			
		L	6 26 ..	20	3			
		L	7 00 ..	16				Small.
		F	7 45 *ca*					
18		e	10 51 ..					
		L	10 57 ..					Very small sinusoidal.
		F	11 09 ..					
21		eL	1 46 ..					
		L	1 48 12	12				Small.
		F	2 00 *ca*					
21		*O*	10 12 48				3,600	
		eP	10 19 36					
		$PR2_N$	10 20 40					
		iS	10 25 00					
		eL	10 29 ..					
		L	10 32 33	30	11	18		
		L	10 36 ..	12	2.5	2.5		
		F	11 07 ..					
22		e	17 54 58					
		e_E	18 07 45					
		eL_N	18 13 ..	50				Small.
		L	18 22 ..	23				Do.
		L	18 28 ..	19				
		L	19 14 ..					Small sinusoidal.
		F	19 26 ..					
23		eL	2 54 30					
		L	2 58 ..	15				
		F	3 04 ..					
23		eL	15 37 30	15				Small sinusoidal; irregular; may not be seismic.
		F	15 50 *ca*					
24		e	2 46 45					
		eL	2 52 ..					
		L	3 04 ..					
		L	3 11 ..	16	2	2		
		L	3 21 30	21	3.5	3.5		
		F	4 40 *ca*					
27		e?	3 03 ..					Trouble with timing shutter.
		eL	3 20 ..					Small.
		L	3 26 24	23				
		L	3 34 30					
		F	4 02 *ca*					
27		eL	10 25 30	30				Small; trouble with timing shutter.
		L	10 28 ..	20	3.5	3.5		
		F						Lost.
27		eL_E	20 44 30					
		L_E	20 47 30	15				Small.
		L_N	20 48 48					Do.
		L	20 54 ..					
		F	21 07 *ca*					
28		*O*	9 52 00				7,960	
		P_N	10 03 19					
		S_E	10 12 37					
		e	10 14 45					L mostly irregular until about 10:40; thin small sinusoidal.
		e	10 15 28					
		$SR2?_E$	10 20 23					
		eL?	10 24 ..					Small.
		L	10 35 ..	15				Do.
		M_N	10 40 ..	15		2.5		
		F	11 50 *ca*					
31		eL_E	12 55 ..					Early phases lost in micros; EW better marked.
		L	13 00 ..	15				
		F						

TABLE 2.—*Instrumental seismological reports, May, 1924*—Continued

CANADA.—*Meteorological Service of Canada, Toronto*

1924			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
May 1		eL	4 40 28					N-S component, barely effected.
W		L	4 51 13					Sinusoidal.
		L	4 52 to 4 53 45	15		2		
		F						Micros.
1		O	19 54 18					P preceded by micros.
W		eP	20 00 50 53					
		iS	20 06 00	6				
		iSR	20 06 29 44	10				Active disturbance
		i	20 08 30	15			3,400	
		L	20 10 41					
		M	20 16 59	11		56		
		F						Slight wind effect.
		O	19 54 24					
		iP	20 00 53	8 to 4				
N		PR	20 05 15					
		S	20 06 00					
		iSR	20 06 30	15	48			Well defined.
		iL	20 10 23					
		M	20 16 10	14	82		3,350	
		F	23 10 ..					
2		L	2 34 23	15		1		N-S component not effected.
		L	2 52 23					
W		F	3 09 ..					
3		e?	12 14 53					Small. N-S component not effected.
		L	12 33 27					
W		F?	12 50 ..					
4		i	17 15 09					Lines crossing and bunched.
		i	17 16 14					
W		L	?17 20 15					
		e	17 14 58					
		iS?	17 17 08					
N		L	17 20 47					
		L	17 36 30	15	6			
		L	17 55 08	10				
		F	19 42 ..					
5		i	6 21 10					N-S component, not effected.
W		L	6 28 00	10				Small sinusoidal waves from 6: 24: 15
		F	6 58 00					
6		L	3 45 30					Prolonged small sinusoidal waves at intervals.
W		L	3 54 15 4 06 23	15		3		
		L	4 14 18	15				
		F	4 46 ..					
		L	3 54 45					
N		L	4 15 08					Very small.
		F	4 38 00					
6		L	6 51 26					Sinusoidal.
W		L	6 53 15 7 02 ..	15		4		
		F	7 20 ..					
		e	6 53 09					
N		L	6 56 15		2			
		F	7 00 ..					
6		e	10 48 30					
W		e	10 48 53					
		eS	10 57 00					
		L	11 00 15	15		4		
		L	11 02 28	15		6		S poorly defined.
		F	11 34 ..					
		iP	10 48 32					
N		i	10 48 53					
		iS	10 57 02					
		e	10 58 53					
		L	11 00 ..				7,020	
		L	11 00 38					Irregular.
		L	11 02 45	17	4			
		F	11 33 ..					
6		eP?	16 29 01					
		P?	16 29 03					
W		e	16 37 08					
		e	16 38 38					
		e	16 39 24					
		e	16 45 45	15		9		
		L	16 57 32					Sinusoidal.
		L	17 02 15	30-38				
			17 13 38					
		M	17 09 08			53		
		L	17 14 38	23				
		F	19 08 ..					
		eP	16 29 00					
N		PR	16 29 41					
		eS?	16 39 21					
		L	16 45 48	15				
		L	17 04 45	38	26		9,220	
		L	17 24 38	17	14			
		F	19 00 ..					
7		e	1 33 38					
W		L	1 37 08					Small.
		F	2 28 ..					

CANADA—*Meteorological Service of Canada, Toronto*—Continued

1924			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
May 7		e	1 33 38					
N		L	1 53 08					Very small.
		F	2 28 ..					
7		L	13 09 11					Very small. E-W component affected by N and NE winds.
N		F	13 23 00					
8		L	6 11 38					
		L	6 19 30					
W		e	6 23 38					
		L	6 37 09	15		3		Sinusoidal.
		L	6 55 08	15		4		
			6 56 52					
		F	8 08 ..					
		L	6 11 36					
N		L	6 28 38					Slightly sinusoidal. Very small.
		L	6 38 10					
			6 39 00					
		F	7 24 ..					
10		i	3 15 45					
		e	3 19 52					
		L	3 51 23	15				Slight sinusoidal.
			3 54 00					
W		L	3 55 58	17				
		L	3 57 45					At intervals.
		L	4 18 ..	15		5		
		F	4 52 00					
		L	3 43 08					
N		L	3 51 35					Very small amp.
		L	4 05 45					
		F	4 32 ..					
11		e	4 52 28					
W		e	4 56 45					Very small.
		F	5 10 ..					
		e	4 56 25					Barely noticeable.
N		F	5 06 ..					
11		L?	?16 46 08					
W		L	16 49 41					Wind effect Small. N-S component barely affected.
		F						
13		L	2 38 53					
W		F	2 47 ..					Very small. N-S component not affected.
13		e?	19 24 36					Doubtful as to being seismic.
		e	19 48 23					
W		L	19 50 23	23		3		
		F	20 01 00					
		e	19 24 38					
N		e	19 38 45					
		L	19 42 08					Very small.
		F	19 59 ..					
17		e	4 21 37					
		e	4 39 22					
W		L	4 41 22	23				Sinusoidal.
		L	4 44 31	23		5		
		L	4 55 30					
		F	5 31 ..					
		e	4 36 38					
N		L	4 50 30					Very small.
		F	5 23 ..					
17		e?	5 36 24					
		iP	5 37 25	5				
		e	5 38 44					
W		S	5 47 27 30	11				
		eL	5 54 23	15				
		L	6 30 10	19		5		
		F	?7 56 ..					
		eP	5 37 21	8				
		PR	5 38 45					
N		iS	5 47 25	10				
		L	5 58 48					
		eL	6 18 45	30				
		L	6 24 00	23	6			
		L	6 38 53	22			8,880	Sinusoidal.
		L	6 40 ..	17	4			
			6 43 38					
			6 52 38					
			6 54 00					
		F	7 37 ..					
18		L	10 18 45					Very small. E-W component affected by wind.
N		F	11 12 ..					
21		L	1 44 23	15		3		
W			1 45 38					Sinusoidal.
		L	1 46 15	10		3		
		F	2 00 ..					

TABLE 2.—*Instrumental seismological reports, May, 1924*—Cont.

CANADA.—*Meteorological Service of Canada, Toronto*—Con.

1924			H. m. s.	Sec.	μ	μ	Km.	
May N		L	1 46 30	10	2			Marked suinsoidal waves from.
			1 49 ..					
		F	1 58 ..					
21		P	?10 19 15					
		S	10 24 15					
W		SR	10 26 28	5				
		iSR	10 27 17	8			3,240	
		i	10 28 08	5				True P may not have been recorded.
		L	10 30 23					
		L	10 31 00					
		L	10 34 30	15		5		
		F	11 02 ..					
		P	10 18 21				(3,280)	
		iP	10 19 14				(4,160)	
N		iS	10 24 17	5				
		i	10 27 25					
		L	10 31 15					
		L	10 34 12	15	4			
		F	10 48 ..					
22		L	18 13 50	23				N-S component, very little affected.
W		L	18 25 15	23				Wind interfered with early phases.
		L	18 26 38					Sinusoidal
			18 28 35	23		8		
		L	18 32 00	15				Wind effect.
23		L	2 56 30					N-S component, not affected. Small.
W		F	3 06 ..					
24		e	2 52 38					
		L	3 11 30	15				
W		L	3 20 00	23		6		Sinusoidal at intervals.
		L	3 30 00	23		2		
			3 46 ..					
		F	4 40 ..					
		L	3 11 35					
N		L	3 20 00					Very small.
		F	3 52 ..					
27		eP	10 18 25					P preceded by micros.
		PR	10 19 23					
		eS	10 23 27	10				
W		L	10 25 ..					
		L	10 25 45	23		3		
		L	10 26 30	23		11	3,270	
		L	10 30 23	10				
		F	11 16 ..					
		PR	10 19 00					
		iS	10 23 26	5 to 10				
N		L	10 26 38	23	7			Sinusoidal.
			10 29 15					
		F	11 15 ..					
27		L	20 45 08					N-S component very slightly affected.
W		L	20 48 30					Slow waves, small amplitude.
		F	21 06 ..					
28		O	9 51 53					
		eP	10 03 17					
W			10 03 23					
		iS	10 12 39	8		7	8,050	
		i	10 12 45					
		e	10 14 30					
		e	10 15 38					
		L	10 23 ..					Slight sinusoidal.
			10 23 30	15				
		L	10 28 23			3		Irregular.
		L	10 33 38	17		6		
		F	11 58 ..					
		O	9 52 01					P & S well defined.
N		iP	10 03 22					
		e	10 10 53					
		iS	10 12 41	8			7,990	
		i	10 12 57	10				
		e	10 14 47					
		e	10 15 46					
		L	10 21 23	18				
		L	10 24 12					
		L	10 28 52	15	5			
		F	12 00 ..					
31		L	12 55 47					
W		L?	13 00 38					Very small.
		F						Heavy micros.
N		i?	13 28 10					
		L	13 28 22					Very small. Irregular.
		L	13 32 38					
		L	13 46 23	15				
		F						Micros.

Reports for May, 1924, have not yet been received from the following stations:

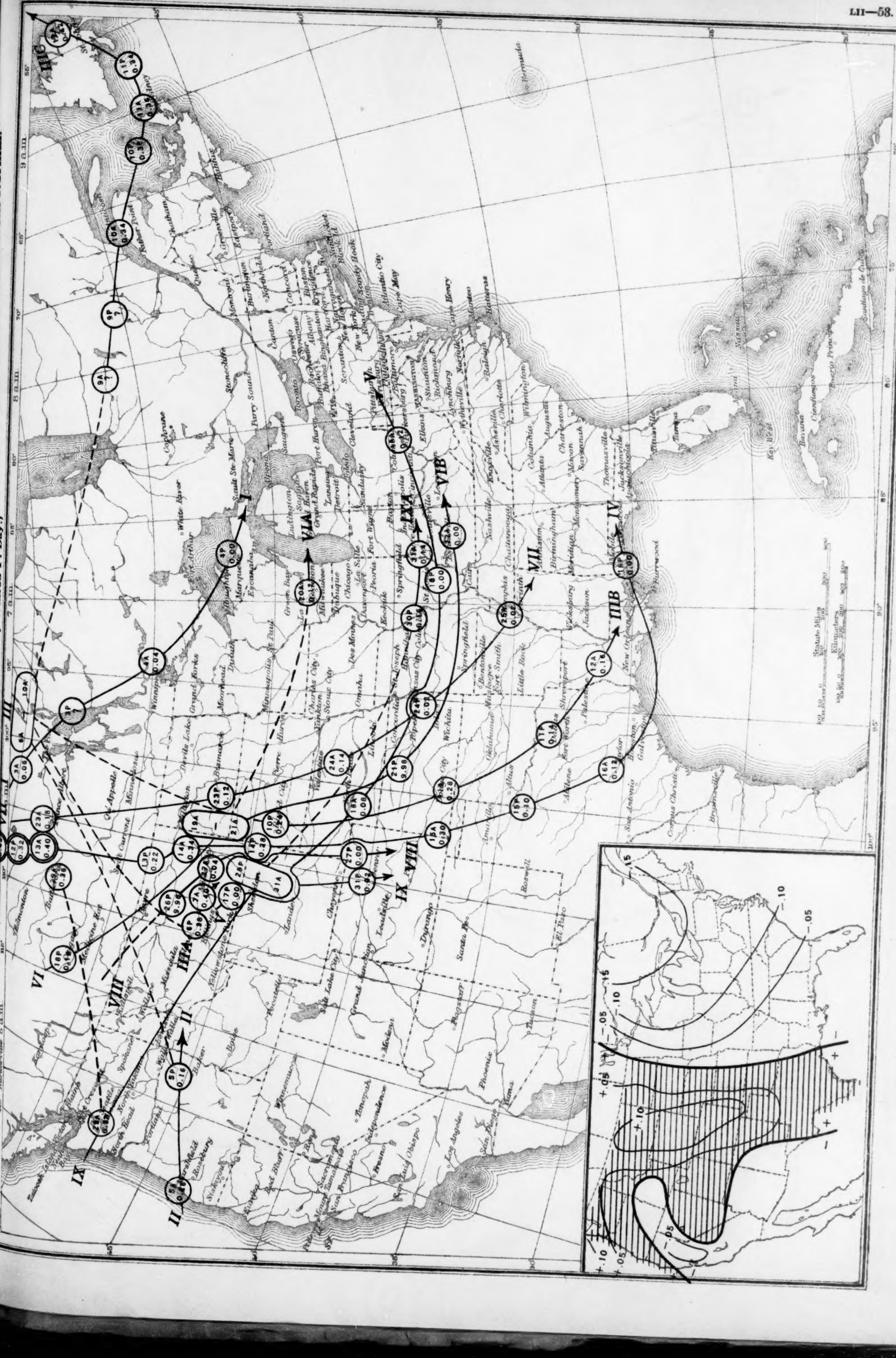
DISTRICT OF COLUMBIA.—*Georgetown University*, Washington.
MASSACHUSETTS.—*Harvard University*, Cambridge.
MISSOURI.—*St. Louis University*, St. Louis.
NEW YORK.—*Cornell University*, Ithaca; *Fordham University*, New York.
CANADA.—*Meteorological Service of Canada*, Victoria.

TABLE 3.—*Late reports (instrumental)*

DISTRICT OF COLUMBIA.—*Georgetown University, Washington*

1924			H. m. s.	Sec.	u	μ	Km.	
Mar 4		eP_E	10 13 49					
		eP_N	10 13 51					
		eS_E	10 18 50					
		iS_N	10 18 58					
		eL	10 21 ..	27				
		M_E1	10 24 58	22	*9,200			
		M_N1	10 26 ..	11		*4,000		
		M_E2	10 30 ..	20	*3,000			
		F						Lost in next quake, and changing sheets.
4		eL	11 59 12					
		F	14 *ca.*					
4		e	17 31 ..					Very heavy micros.
		L_N	17 34 41					
		F	17 50 ..					
5		eL_E?	12 23 24	16				Very heavy micros.
		F?	13 *ca.*					
6		e_N	12 36 45					Rest doubtful; heavy micros.
7		e_N?	18 20 40					Very heavy micros.
11		eP_N	10 46 45					P and S uncertain; very heavy micros.
		eS_N?	10 52 23					
		eL?	10 55 00					
		L_E	10 57 33	16				
		L_N	10 58 ..	16				
		M_E	10 58 35		*1,800			
		F	12 50 ..					
13		e_E	11 05 ..					Sheets off 11:31; quake still on. Very heavy micros.
		e_N	11 03 ..					
15		eP_N	10 44 05					
		eS_N	10 54 29					
		eL_E?	11 11 36	16				
		L_E	11 19 28	16				
		F	11 55 ..					
20		L_E	10 13 *to*	16				Very heavy micros.
			10 18 ..					
24		eP_N	20 36 ..					Phases very difficult.
		S_N?	20 40 36					Very heavy micros.
		eL_E?	20 43 18	10				
		L_E	20 45 ..					
		L_N	20 47 27	16				
		F	21 15 ..					
25		eP?	14 13 10					S_N uncertain.
		S_E?	14 20 27					
		eL	14 23 12	22				
		L_E	14 25 06	11				
		L_N	14 26 11	15				F in next quake.
25		eP_E?	15 09 27					Very heavy micros.
		eP_N	15 09 38					
		eS_E?	15 17 13					
		eL	15 19 54	17				
		L_E	15 21 11	11				
		L_N	15 22 27	11				
		F	16 *ca.*					
30		e?	0 25 ..					Pronounced, but difficult; very heavy micros.
		S_E?	0 29 26					
		S_N?	0 29 22					
		F	1 30 ..					

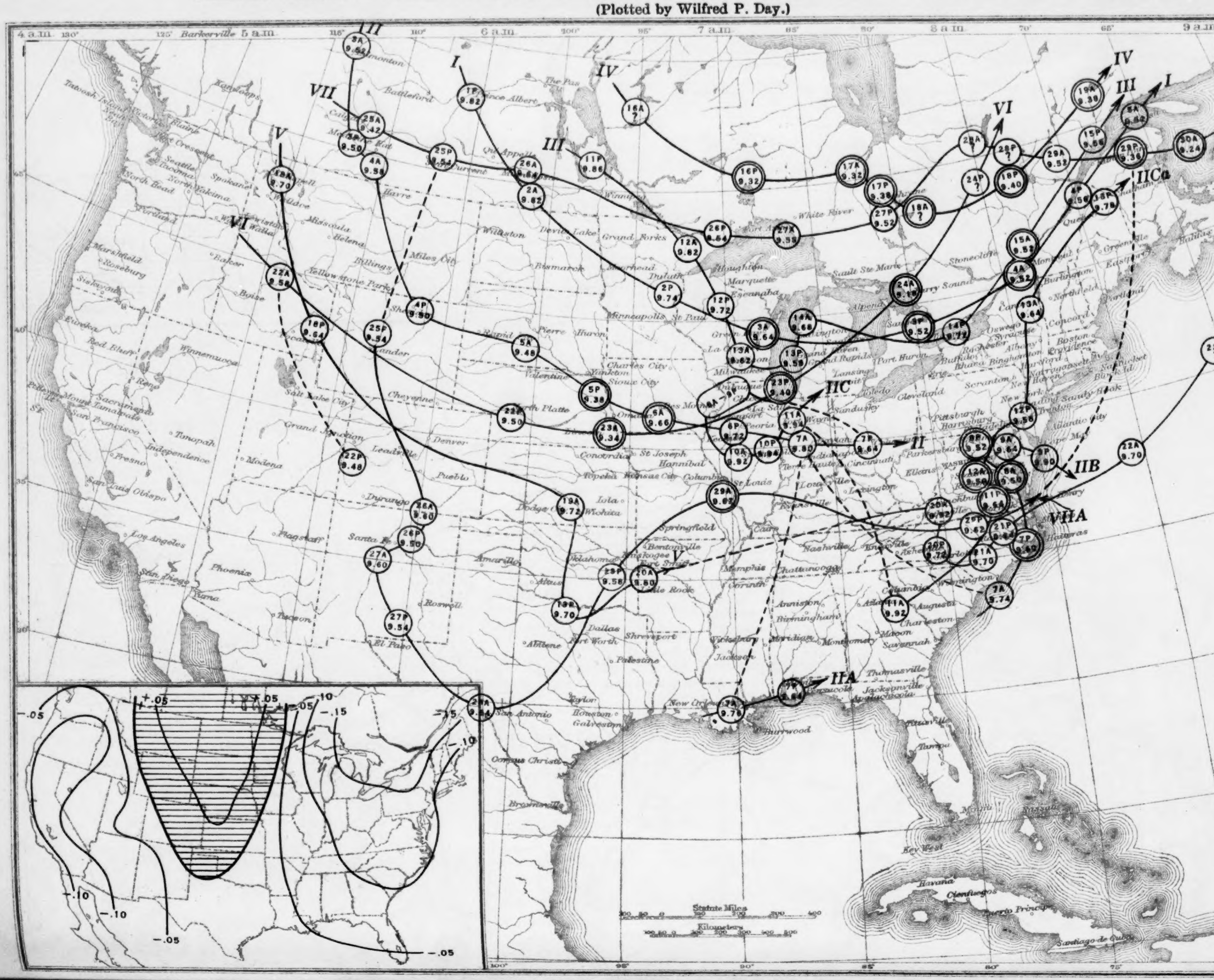
* Trace amplitude.



(Plotted by Wilfred P. Day.)

Chart II. Tracks of Centers of Cyclones, May, 1924. (Inset) Change in Mean Pressure from Preceding Month.

(Plotted by Wilfred P. Day.)



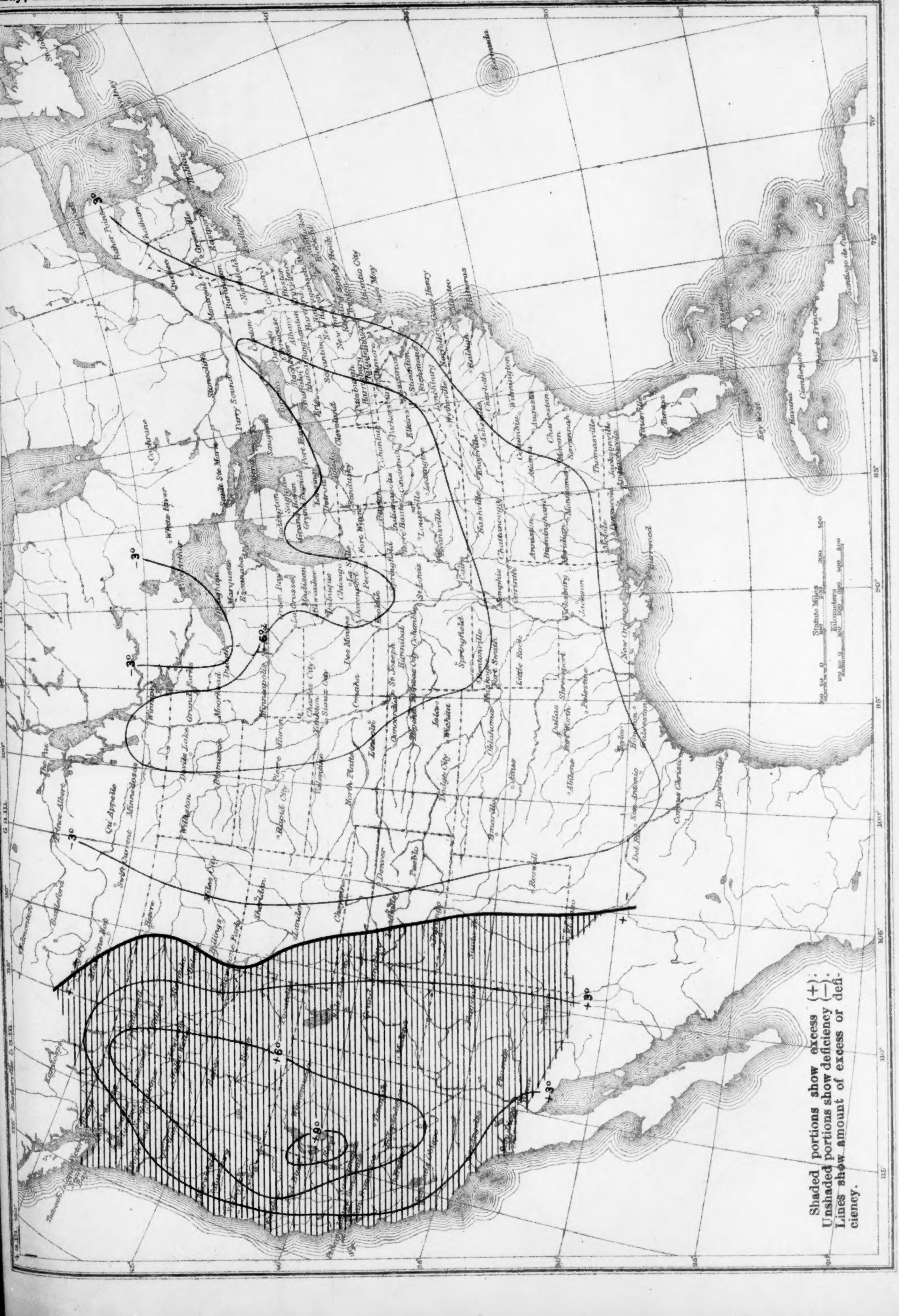


Chart III. Departure (°F.) of the Mean Temperature from the Normal, May, 1924.

Chart IV. Total Precipitation, Inches, May, 1924. (Inset) Departure of Precipitation from Normal.

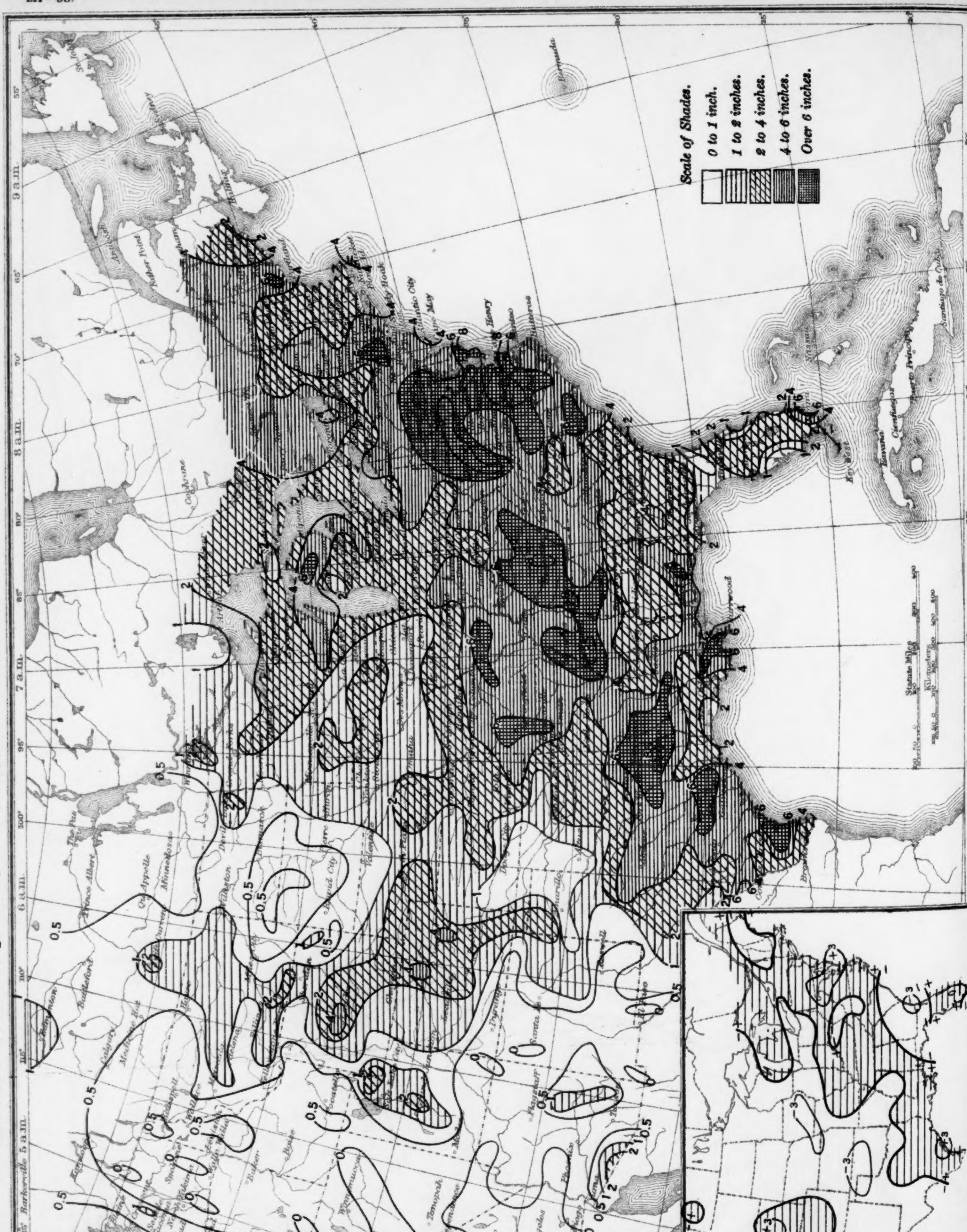


Chart V. Percentage of Clear Sky between Sunrise and Sunset, May, 1924.

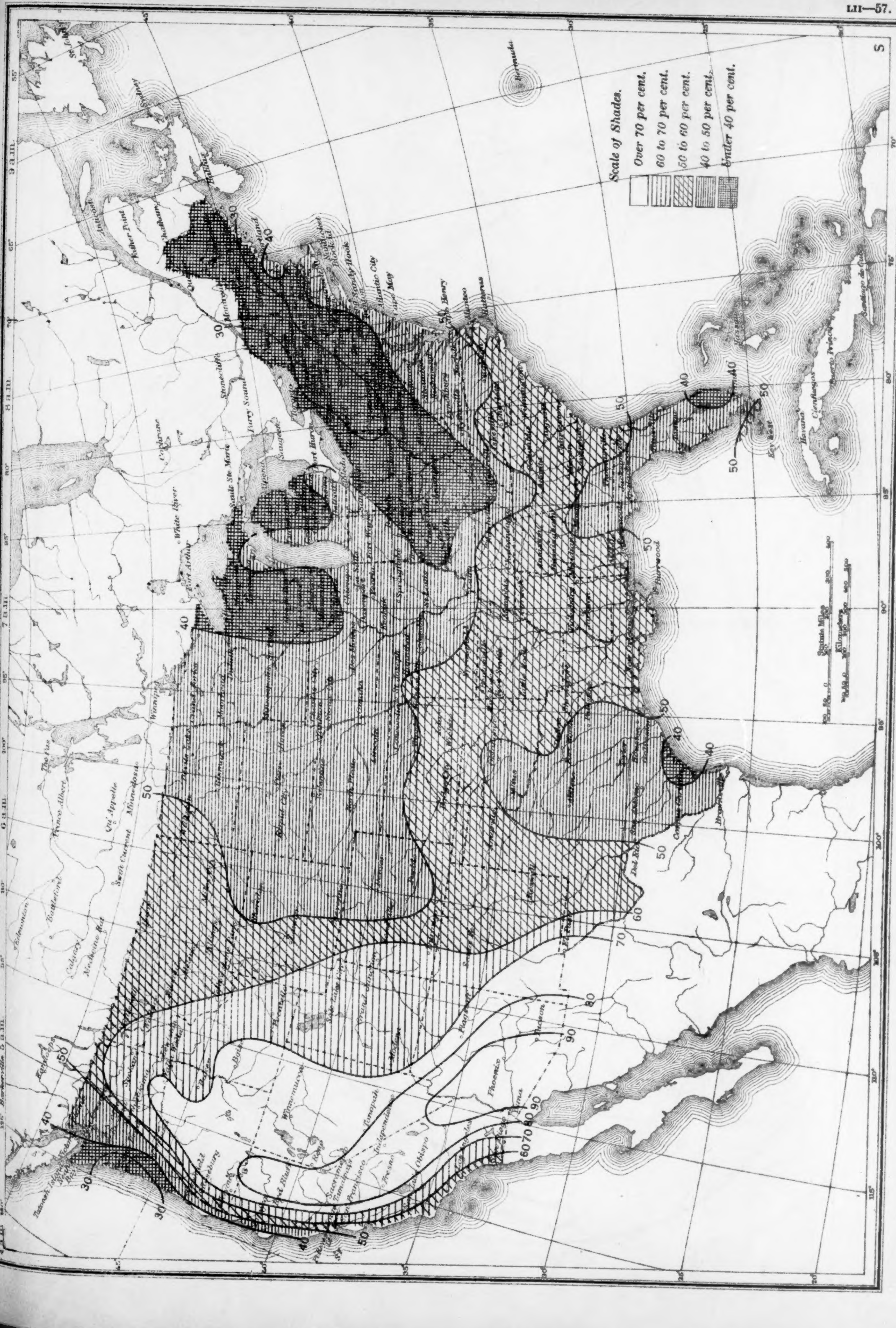
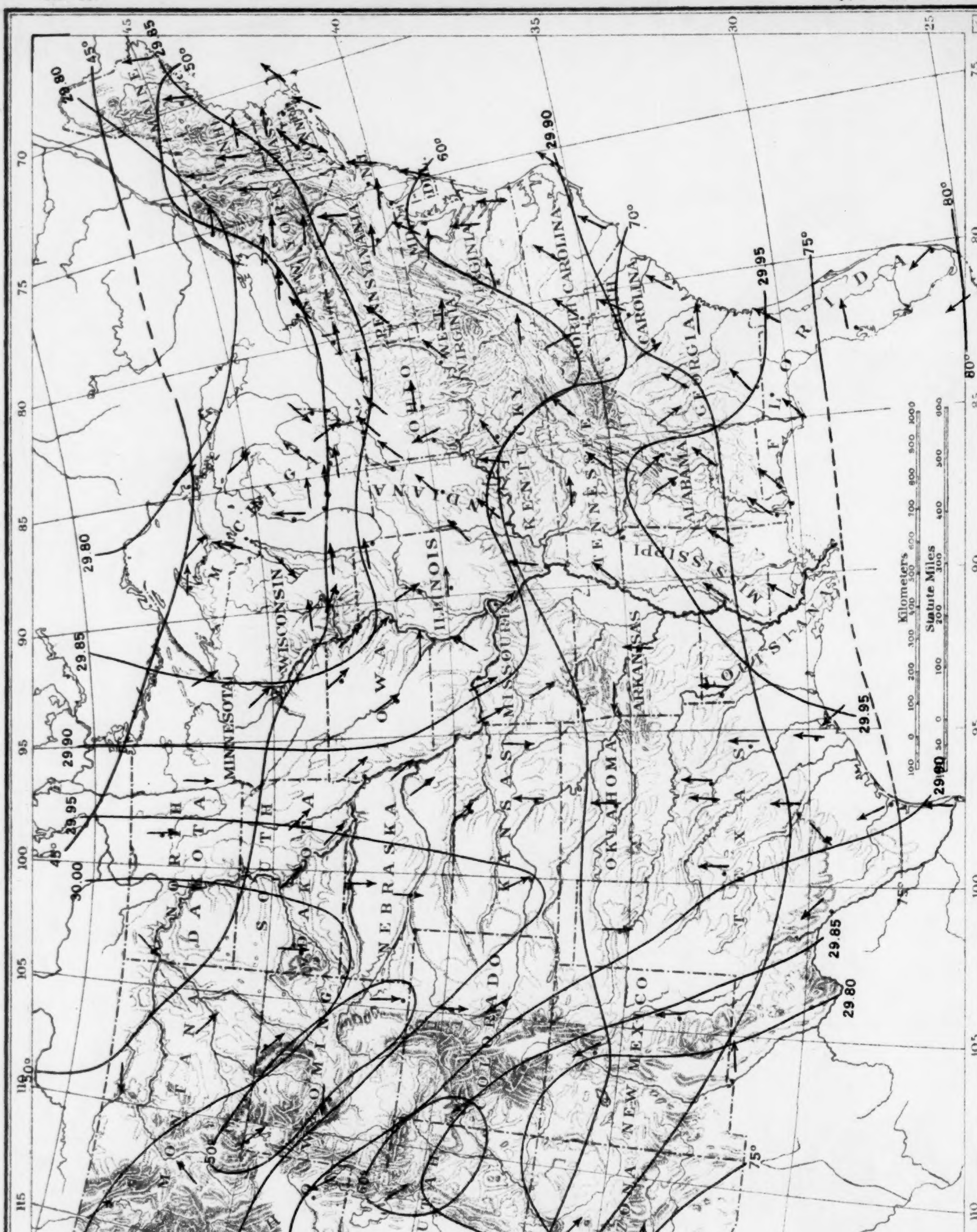


Chart V. Percentage of Clear Sky between Sunrise and Sunset, May, 1924.

Chart VI. Isobars at Sea level and Isotherms at Surface; Prevailing Winds, May, 1924.



(Plotted by F. A. Young.)

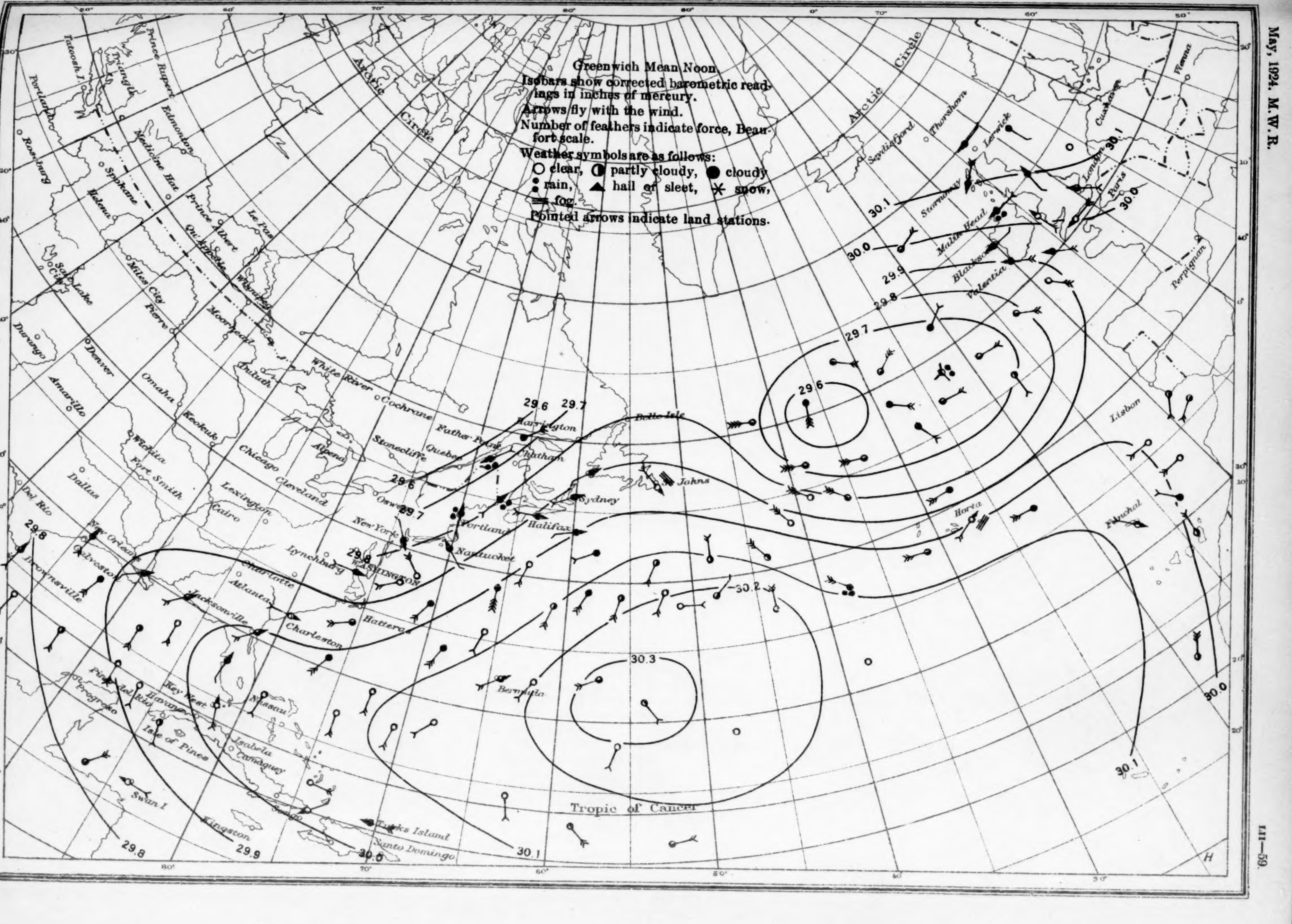


Chart IX. Weather Map of North Atlantic Ocean, May 29, 1924.

(Plotted by F. A. Young.)

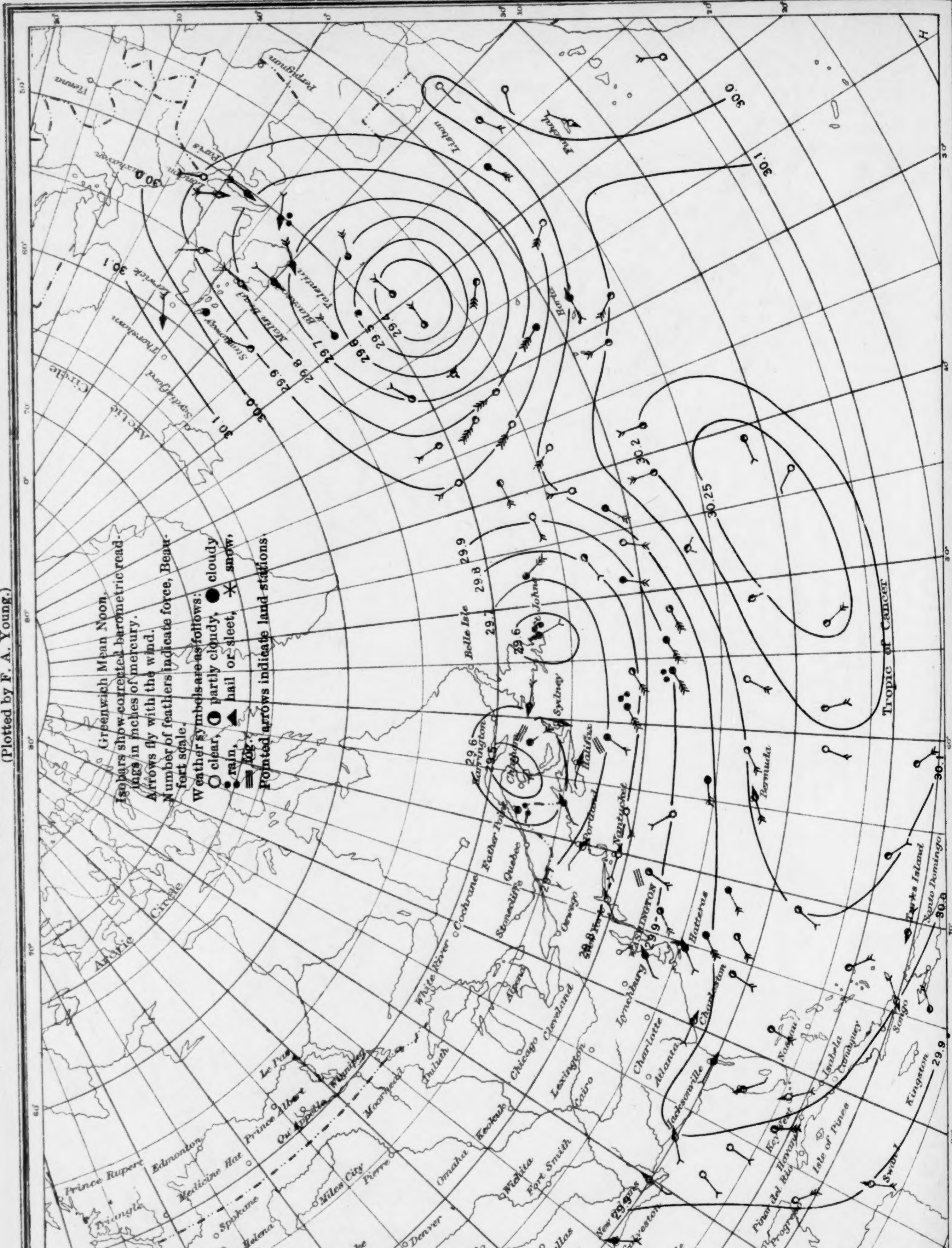


Chart X. Weather Map of North Atlantic Ocean, May 30, 1924.
(Plotted by F. A. Young.)

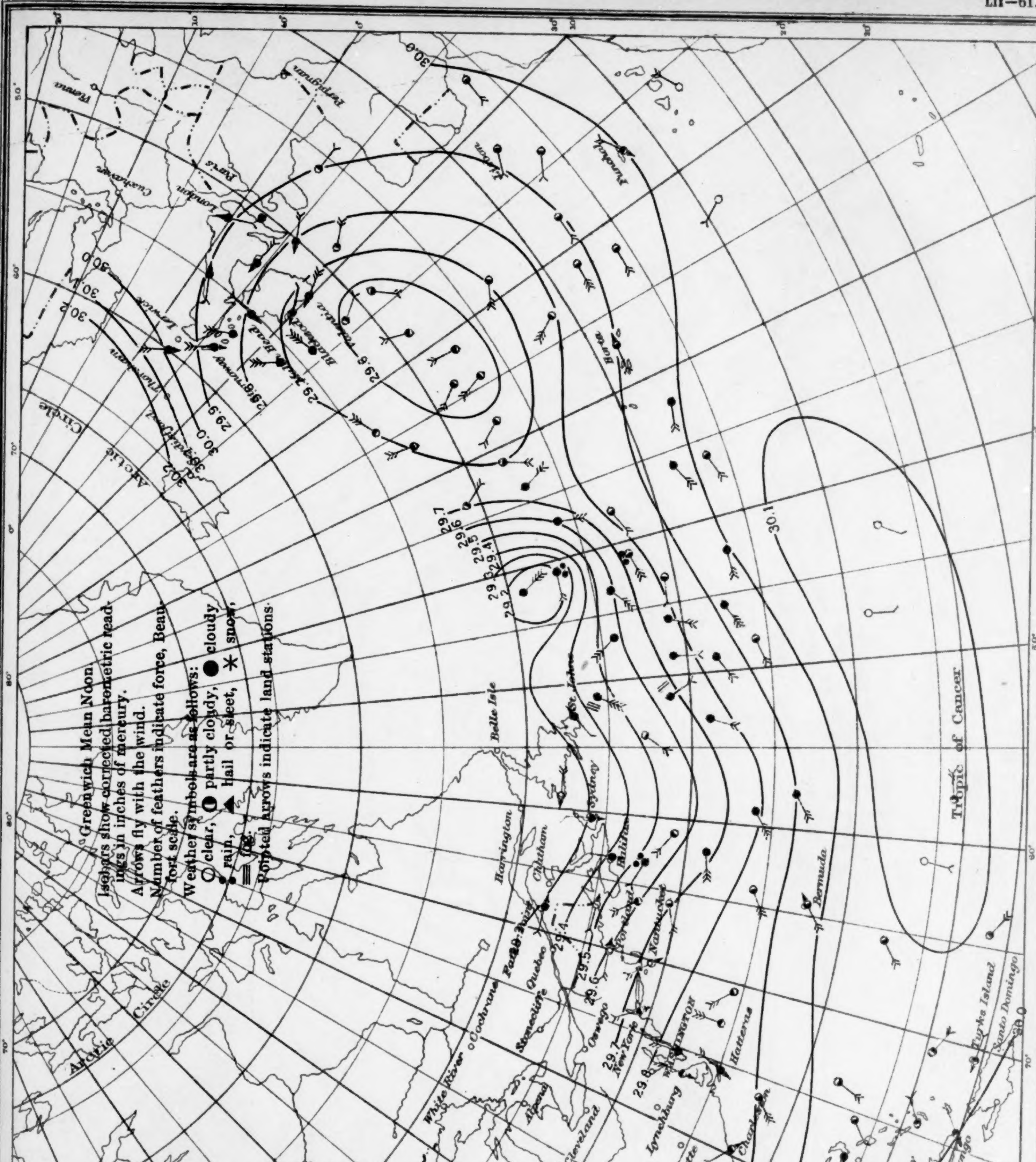


Chart XI. Weather Map of North Atlantic Ocean, May 31, 1924.
(Plotted by F. A. Young.)